Technological Spillovers from Foreign Direct Investment and Industrial Growth in China

By

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Except where otherwise acknowledged,
this thesis represents my original research.

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Dedicated to my parents.

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Abstract

The role played by foreign direct investment (FDI) in transferring technology and improving productivity growth of domestic firms is defined as 'spillover effect'. The recognition of this role has driven the Chinese government to implement measures to attract FDI, especially FDI in high tech industries since the initiation of economic reform in 1978. China has gradually emerged as a major host country to FDI. However, the great bulk of FDI into China has been concentrated in small, labour intensive operations, much to the disappointment of the Chinese government.

In order to evaluate FDI policies in China and to formulate rational policies for the future, this thesis raises two central questions:

(i) First, given the existence of FDI in the Chinese economy, will technology necessarily spillover to domestic firms?

(ii) Second, and more importantly, what are the principle determinants of spillovers from FDI to domestic firms?

In an attempt to find answers to these questions, this study combines theoretical analysis, empirical analysis, and detailed case studies. The theoretical framework is laid out through a partial equilibrium model which explores ways in which a domestic and a FDI firm interact. The empirical analysis begins by investigating the differences in growth performance between domestic firms and FDI firms. This comparison is necessary because spillover effect can only take place if foreign firms have a higher rate of TFP growth compared with domestic firms.

Explicit analysis of spillover effect is first conducted by investigating how spillover effect differs between state-owned and collectively owned firms. Owing to different ownership structures, firms in these two categories have substantially different attitudes and have made different efforts to develop technology. An understanding of these differences will shed light on how domestic firms' incentives and their consequent efforts to improve technology affect spillover effects. The analysis also investigates how spillover effect differs between firms in different industries. Domestic firms' ability to improve technology and compete with foreign firms emerges as a key determinant of spillover effect from result of empirical analysis.

Finally, information from firm interviews is analysed to examine the channels of spillover effect which are difficult to convey by statistical methods.

The major message of this study is that although the entry of foreign firms provides potential for spillover effect to take place, the actual result is largely dependent on domestic firms' behaviour. Two factors are especially important - domestic firms' incentive and effort to learn from foreign firms, and their ability to absorb new technologies foreign firms bring in. When the learning effort is low, and when the domestic firm cannot effectively compete with FDI firms, domestic firms TFP growth will fall with the expansion of FDI firms' production. Therefore, measures that enhances domestic firms' incentives to improve technology, and to improve domestic firms' technological capability will contribute to increased spillovers from FDI. In the Chinese case, continued economic reform will enable domestic firms to operate according to market rules and to compete on a level playing field with FDI firms. Thus can be expected to increase domestic firms' effort and ability to benefit from spillover effects derived from FDI.

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Chapter 1

Introduction

Over the past two decades, foreign direct investment (FDI) has surpassed all other forms of private foreign capital flow to developing countries. In 1980, FDI flows to developing countries were US$ 2.0 billion per annum, compared with a portfolio investment of US$ 17.34 billion per annum. By 1985, FDI had increased to US$ 12.5 billion, while portfolio investment decreased to US$ 4.3 billion. In 1990, FDI to developing countries increased to US$ 31.6 billion, and tripled to US$ 107.5 billion by 1995. During the same period, portfolio investment experienced a much lower increase, from US$ 2.5 to US$ 42.2 billion (IMF: Balance of Payment Statistics Yearbook, various years). Indeed, foreign direct investment has become a major force in the global economy.

The growing recognition of the need for FDI in economic development has been at the root of this dramatic increase. In the 1960s and 1970s, FDI was frequently regarded as a force that suppressed and distorted the development process. It is now widely recognised that foreign investment can contribute to economic development by being a source of capital formation, a vehicle of technology transfer, and an agent for transforming the industrial structure of an economy (Lloyd 1996). Many developing countries, including some formerly centrally planned countries such as China and Vietnam, have promulgated new foreign investment laws aimed at attracting foreign capital and technology.

Technology transfers are considered to be the most important mechanisms through which FDI promotes growth in a host country. This is because the fundamental determinant of modern economic growth is cumulative technological change. As Mansfield et al. (1982, p.1) wrote: 'Technological change has permitted the reduction of working hours, improved working conditions, provided a wide variety of extraordinary new products, increased the flow of old products, and added a great many dimensions to the life of our citizens'. Correspondingly, modern economic growth is closely related to the process by which technological changes have been diffused, imitated, and adapted. During this process, foreign direct investment has played a major role. The importance of this role needs little defence because technological progress is central to the development process. The neglect of this technological aspect can lead to a serious underestimation of the role of foreign direct investment in recipient countries. It is this important role that has led many to believe that

> 'Transnational corporations, in pursuing their economic objectives, can make a contribution to the development process by providing capital, technology, managerial resources, and market' (CTC Reporter 1986, p.9).

1.1 FDI, Technology Spillovers, and Growth

The essence of modern economic growth lies in the rise in the stock of knowledge and the extension of its application. The progress of technology is determined by two processes - innovation and technology transfer. Innovation is the process by which new processes and products are created, and technology transfer is the process by which the new technology spreads beyond the innovators. Since innovations can not be confined to the borders of any one nation, the economic growth of all countries depends to some degree on the successful application of the technology transferred (Byun and Wang 1995).

Three major channels have been identified for technology diffusion, namely FDI, trade in capital goods, and trade in technology (Mowery and Oxley 1995). Among these, FDI has been the most important channel in recent years. A survey of 474 Japanese manufacturers showed that about 56 percent of technology transfer in Asian countries in 1990 was undertaken as part of FDI, 40 percent in the form of licenses, and the remaining 4 percent through other channels (Tran and Urata 1995).

FDI may be broadly defined as the establishment of, or acquisition of, substantial ownership in an enterprise in a foreign country (CTC Reporter 1986, p.150). While portfolio investment implies a transfer of capital only, FDI entails a cross-border transfer of a variety of resources. In the view of industrial organisation theory of FDI (Caves 1971,1974; Hymer 1976), MNCs face some disadvantages imposed by both geographic and cultural distances in competition with indigenous firms. To overcome the inherent disadvantages, MNCs must possess some kind of ownership advantage in order to compete with local enterprises. These ownership advantages can be expressed as technology, cost effectiveness, established market, and financial strength (Dunning 1970). In order to operate in foreign countries, MNCs undertake a major part of the world's private R&D (Byun and Wang 1995). Therefore, FDI represents transmission to the host country not only of capital, but also of a package of technologies, including process and product technology, managerial skills, marketing and distribution know how, and human capital. But these facts leave open the questions of whether and how the technology of a MNC is transferred to domestic firms.

FDI potentially affects the growth of host countries by acting as a vehicle through which new ideas, technologies, and working practices can be established. Various channels through which FDI may affect growth have been suggested. Knowledge and technology could diffuse from foreign to domestic firms through the training of labour, and labour turnover from MNCs to domestic firms, and through linkages between foreign firms and local suppliers and customers. Local firms can also learn by watching. Moreover, the very presence of foreign owned firms in an economy increases competition in the domestic market. The competitive pressure may force local firms to operate more efficiently and introduce new technologies earlier than would otherwise have been the case (Blomstrom 1989). In these cases, a foreign presence would raise the productivity of domestic firms. Because the foreign firms are not able to extract the full value of these productivity gains, this process has been defined as 'externality', or 'spillover effect'. Thus, the term 'spillover' has a broader meaning than 'technology transfer' (Kokko and Blomstrom 1995).

Spillover effects have been suggested as the most significant channel for the assimilation of modern technologies from FDI. In a detailed study of technology export by American firms, Mansfield and Romeo (1980) found that in about one third of cases, the export of technologies from parent companies to U.S. affiliates abroad speeds up the emergence of updated products or processes in the host countries by an average of 2.5 years. FDI also transfers more advanced technologies than alternative channels. According to Mansfield et al. (1982), the average age of technologies transferred to their developing country subsidiaries by U.S. firms during the 1960 to 1978 period was 9.8 years, compared with 13.1 years for technologies transferred via licensing or joint ventures. Mansfield et al (1982) also provided estimates of how rapidly technologies spillover from US MNC subsidiaries to other firms, after the initial transfers from MNCs to their subsidiaries. It is reported that technology transfer hastened non-US firms' access to the technology by 3.1 years for process technology and 0.4 years for product technology.

As developing countries move up the technological ladder and the technology gap between them and the advanced industrial countries narrows, it may become more difficult to obtain technology through licensing agreements. There are fewer sources of supply and firms are more reluctant to license technology to firms that are strong competitors. For example, Mowery and Oxley (1995) show that although the importance of FDI in the early stages of economic development has varied among the East Asian Newly Industrialised Economies (NIEs), the high technology sector in all of those economies has increasingly relied on technology transfer through FDI as they move closer to the technology frontier.

In some fields, FDI may be the only way to obtain the latest technology. For example, the demonstration of modern management techniques. The practices of well-run foreign companies can expose the weak links of domestic firms in areas such as management, product design, and material supply. This can push domestic firms and government to undertake changes they may not otherwise have considered. Indeed, it is the ability of FDI to transfer production know-how as well as managerial skills that distinguishes it from all other forms of investment, including portfolio capital and aid.

1.2 FDI in China and Related Questions

FDI in China has been considered as a means to introduce modern technology and stimulate export-led growth since the initiation of economic reform in 1978. This led the Chinese government to explore ways of increasing FDI inflow. Efforts to attract foreign investment constitute one of the most important parts of China's open door policy. Since the initiation of economic reform, a series of measures have been adopted to develop institutional, infrastructure, legislative, and administrative organs to accommodate FDI inflow.

The open-door policy has resulted in an accelerated increase of FDI inflow. From 1979 to 1982, foreign direct investment inflows amounted to approximately US$ 1.2

billion. From 1983 to 1990, China approved 28,127 contracts with total utilised foreign investment amounting to US$ 17.8 billion. From 1991 to 1995, utilised FDI in China jumped from US$ 4.4 billion to US $ 37.5 billion. China has also emerged as a major host to FDI in relative terms. In 1996, FDI in China reached US$ 41.7 billion, almost US$ 10 billion more than all other East Asian developing countries combined. In 1990, China's share of total FDI in developing countries was 12 percent, increasing in 1992 to 23 percent, making it by far the largest recipient of direct investment among developing countries. In 1995, China topped the hosts for FDI in developing countries, receiving 33 percent of total FDI among developing economies (China Statistical Yearbook, IMF: Balance of Payment Statistics Yearbook, various years).

Motivated by the desire to obtain modern technology from MNCs to upgrade China's overall technological capabilities and to improve domestic firms' technology levels, the government has been adopting policies specifically designed to promote the inflow of FDI in high technology industries. These measures include preferential treatment in taxation, finance, and trade policies. Once granted the high technology status, technologically advanced projects enjoy benefits such as priority for Bank of China loans, an extended reduction period for income tax, and exemption from withholding tax on profits remitted outside China. Since 1992, significant domestic market access has been given to foreign investment in high technology industries.

Despite the Chinese government's effort to attract foreign investment in advanced technology industries, the great bulk of FDI into China is concentrated in small, labour intensive operations. The sectors with the highest FDI are garments, electronics, textiles, plastic manufacturing, construction materials, and food industries. Some products conventionally classified as capital intensive such as the electronics industry, are actually produced in a labour intensive process in China, in that firms are seldom involved with designing or manufacturing important parts. Instead, assembly, including assembly of materials from abroad, assembly according to designs from abroad, and assembly of spare parts and components from abroad, has been the main components.[1]

[1] These are named 'three assemblies' by the Chinese government.

The inflow of large amounts of FDI in labour intensive industries raises some concerns for the government. A prevailing idea is that FDI in labour intensive sectors offers little toward meeting the official objectives of transferring advanced technology. Many argue that the industrial distribution of FDI is disappointing and the pace of industrialisation in China has been slowed down by the concentration of FDI in labour intensive industries. According to this point of view, the distribution should be 'optimised' by making further effort to attract FDI in high-tech industries (Yang and Wang 1996). This idea dominates official thinking and is explicitly advocated by many economists. For example, Liu (1996) argues that China should implement policies such as 'exchanging market for technology' to encourage investment in technology intensive industries,[2] and should directly require foreign investors to provide advanced technologies, especially those hard to obtain through other channels, in order to substitute for imports.

In order to benefit from the spillover effect, it is important to examine whether policies encouraging FDI inflow, and especially FDI in high tech industries, are able to deliver the government's objectives of transmitting technology from foreign to domestic firms. Two questions are central:

- First, given the existence of FDI in the Chinese economy, will the technology necessarily spill over to domestic firms?
- Second, if not, under what circumstances will technology spillover from FDI to domestic firms?

These are the main questions to be addressed in this study.

1.3 Central Hypothesis

The answers to the above questions depend on whether learning from foreign firms is an effortless and costless process. Most earlier studies conceptualise learning by firms as an automatic process. More recent studies, however, suggest that learning

[2] The basis of this policy is allowing foreign firms access to the Chinese market on condition that those companies bring in advanced technology.

requires firm effort and resources (Mowery and Oxley 1995). Learning is not automatic because technology is largely not a free good. The very fact that technology is not a free good questions the basic assumptions that technology spillovers take place automatically. A number of studies have examined spillovers from FDI in various countries. Spillovers are found to exist only in some countries, suggesting they are not automatic but are affected by various factors.

Technology is an intangible asset which can reduce production costs and increase the attractiveness of firms' products. While technology spillover benefits domestic firms, it represents a cost to foreign firms (Das 1987). Consequently, it is in the interest of domestic firms to increase technology spillovers, while profit maximising behaviour may induce foreign firms to attempt to prevent technology spillover to competing firms. Therefore, while FDI is a potential source of technology spillovers which can benefit domestic firms, FDI inflow itself is not sufficient to ensure that technology spillover will take place. Technological spillovers from FDI to domestic firms depend on strategic interactions between domestic and foreign firms. Based on this consideration, this study formulates a central hypothesis that the presence of foreign direct investment in domestic markets is only a necessary condition for domestic firms to gain from technology spillover from FDI. Actual spillover effects are largely dependent on the domestic firms' behaviour.

1.4 Analytical Framework and Objectives of the Study

When spillover is costly, two factors become important in determining the magnitude of the spillover effect. The first is the domestic firms' incentive to learn from the foreign firms, which in turn determines the domestic firms' effort to learn. Unless the domestic firms put effort into analysing new products and production processes, it will not be possible for them to gain from the technology the foreign firms have brought in. The second is the domestic firms' ability to compete with the foreign firms, which, in turn, depends on the technology gap between the domestic and foreign firms.

To examine these factors, the domestic firms' performance and behaviour must be analysed. In the Chinese context, one has to examine how spillover differs between state-owned and non-state owned firms. In 1995, after nearly two decades of reform, the Chinese economy was neither a stylised market economy nor a typical centrally-planned economy. Large numbers of state-owned enterprises (SOEs) coexisted with non-state owned enterprises. SOEs still employed about 70 percent of urban workers and produced 33 percent of industrial output. On the other hand, economic reform resulted in a rapid expansion of non-state owned firms. In 1992, 51.9 percent of China's total output was produced by the non-state sector. By 1995, the proportion was 65.9 percent. Between firms in state and non-state-owned categories, there are substantial differences in performance and behaviour. How does domestic firms' ownership structure affect the spillover effect from FDI? The answer to this question merits a thorough empirical analysis.

There are two arguments regarding the relationship between the technology gap and firms' potential to benefit from foreign technology. On the one hand, Gerschenkron's (1962) idea that poor countries could take advantage of their relative backwardness suggests that at the lower level of development, there are greater opportunities to borrow foreign technology and hence increase TFP growth. On the other hand, a large body of evidence has found that a large technology gap impedes subsequent growth (Heitger 1993; Pack 1992). How domestic firms' ability to learn from foreign firms and the related technology gap between domestic and foreign firms affect spillover effect needs to be assessed.

The resolution of these questions requires a thorough investigation of how spillover effects differ between state and non-state owned firms, and between high technology and low technology industries in China. Yet, there have been no systematic studies of FDI and spillovers in China. Most existing studies are based on small scale case studies or intuitive reasoning, and there has been very little in-depth empirical analysis. At the theoretical level, there exists no formal treatment of the relationship between FDI and domestic firms' TFP growth in the Chinese context. This lack of rigorous analysis may hamper further rational policy formulation.

Up to now, policy schemes in China, and most developing countries, have tended to focus predominantly on attracting FDI with the implicit assumption that technology will automatically diffuse to domestic firms once the foreign firms enter the domestic market. Policy initiatives have largely bypassed measures to improve the spillover benefit from FDI. Hence, it remains an important task to examine the impact of FDI on China's industrial growth. A careful assessment of FDI and technology spillover in China will shed light on the mechanisms through which technological information leaks out to domestic firms. This study will also contribute to the evaluation of FDI policies in China and to the rational formulation of future policies. Furthermore, this study is likely to provide useful points towards the direction and likely success of FDI and technology transfer in other developing countries, especially the reforming communist economies. As Pomfret (1994) has noted, China provides the most extensive experience of investing in a communist country.

1.5 Methodology

The theoretical framework of this study is laid out through a partial equilibrium model which explores ways in which FDI influences the TFP growth of domestic firms. Based on the situation of Chinese firms, the model focuses on the interaction between a foreign and a domestic firm when the domestic firm faces adjustment costs and when there is a technology gap between the foreign firm and the domestic firm. Unlike most previous theoretical studies, which analyse technology transfer from a MNC to an overseas subsidiary, the model in this study focuses on analysing the relationship between a firm with FDI and a wholly domestic firm.

The empirical analysis utilises econometric modelling to analyse the impact of FDI on domestic firms' TFP growth. FDI entered the equation with TFP growth of domestic firms as the dependent variable along with other variables deemed to influence TFP growth. The recognition of interdependence among various aspects of market behaviour has resulted in the use of a simultaneous equation system rather than a single equation model. Regressions have been carried out to test the effect of both ownership and industry characteristics on the spillover effect.

The spillover effect from FDI in the Chinese economy is also examined by analysing information obtained from firm interviews. This type of case study is necessary because the spillover process contains many intangible elements that cannot be conveyed by statistical methods alone. As a complement to the econometric analysis, the case study focuses on analysing channels of spillover effect.

1.6 Structure of the Study

A brief overview of FDI inflow and its changing pattern in China is presented in chapter 2. Before going into detailed analysis on FDI and spillover effects in China, chapter 3 reviews the relevant literature concerning the issue of FDI and spillovers. To provide a comprehensive background for the analysis in following chapters, the survey reviews theoretical studies of spillover effects, as well as empirical evidence of spillover effects, and studies of foreign direct investment in China. The focus of the literature review is to address the relevance of the literature to the current study and to identify aspects which need to be improved upon in the Chinese context.

Despite the increasing amount of theoretical literature on FDI and spillover effects, few studies focus on the relationship between domestic firms' TFP growth and FDI. In order to map out the analytical framework for this study, a partial equilibrium model is derived in chapter 4 which captures the effect of FDI on domestic firms' TFP growth. This establishes the theoretical framework in which domestic firms interact with foreign firms.

Spillover effects can only take place if foreign firms have a higher rate of TFP growth compared with domestic firms. The analysis of relative performance of TFP growth between domestic firms and foreign firms is therefore necessary before proceeding to analyse how FDI affects domestic firms' TFP growth (Chapter 5).

Explicit analysis of the relationship between FDI and domestic firms' TFP growth is then conducted at two levels.

- First, Chapter 6 examines spillovers by comparing how this effect differs between state-owned and collectively owned firms. Owing to different ownership structures, firms in these two categories have substantially different attitudes and made different efforts to develop technology. An understanding of these differences will shed light on how domestic firms' incentives and their consequent efforts to improve technology affect spillover effects.

- Second, how the domestic firms' ability to improve technology and compete with foreign firms affects spillover is evaluated by analysing how the technology gap between foreign and domestic firms is related to spillovers. In chapter 7, observations in 28 manufacturing industries are divided into four groups according to the observed technology gap between domestic and foreign firms. To focus on the effect of the technology gap, only observations in the collective category are used to conduct the test. The reasons for this will be apparent from the results of Chapter 6.

The econometric analysis provides evidence of causation between FDI and domestic firms' TFP growth. However, these results do not reveal the detailed mechanism through which spillovers take place, nor are they able to estimate the relative importance of different channels of spillover effect. In chapter 8, information from firms interviews is analysed to examine the channels of spillover effect which are difficult to convey by statistical methods. The analysis compares channels of spillover effect between state-owned firms and collectively owned firms, and between firms in high and low technology industries.

The final chapter (chapter 9) summarises findings and policy implications, identifies the problems of the study, and suggests directions for future research.

Chapter 2

An Overview of Foreign Direct Investment in China

In the late 1970s, after nearly three decades' of isolation, China's economy was dominated by outdated technology and industrial facilities. Most industrial equipment was imported during the 1950s from the former Soviet Union, China's major political and economic ally at that time. With the termination of Soviet assistance in the 1960s, and the continuation of self-sufficient policies, China continued applying 1950s' vintage Soviet technology. Scientific research was limited to a few priority areas such as nuclear weapons industries. This neglect severely constrained technological progress, and the gap between China and advanced countries continued to widen. With the change of leadership during the late 1970s, China began a new drive to modernise the economy. The acquisition of advanced technology was given high priority in the national economic development policy programs (Warhurst 1991).

It was agreed that 'China must develop its own high-tech industries, as otherwise it would never be able to modernise its economy' (Huang and Yang 1998, p.8). Improved technology was seen as the key to shifting from extensive growth, based on accumulation of capital, to intensive growth, based on productivity and quality change. While China could have developed some of these technologies independently, it would have been time consuming and extremely costly in terms of R&D. Therefore, foreign investment was considered to be a logical alternative to upgrading and modernising China's technology. Since the initiation of economic reform in 1979, China has actively implemented measures to acquire FDI together with advanced technology, in pursuit of this goal. The objectives of inducing FDI, as stated in the Law of China on Joint Ventures between Chinese and Foreign Investment, included:

- To utilise foreign capital to boost China's economic development.
- To gain access to foreign markets and promote exports in order to increase foreign exchange earnings,
- To absorb advanced technology and improve economic efficiency.
- To learn and master advanced managerial skills through cooperation with foreign companies.

Since 1979, China has promulgated more than 60 laws and regulations on foreign economic relations. The sheer number of laws and regulations is indicative of the continued effort of the Chinese government in pursuit of FDI to fulfil its economic development goals (Kwon 1989). In the following sections of this chapter, an overview of FDI inflow in China and its changing patterns is provided.

2.1 FDI Inflow and Related Policies in China

The enactment of the 'Law of the People's Republic of China on Joint Ventures Using Chinese and Foreign Investment' on July 1, 1979 at the Fifth-National People's Congress marks the commencement of the effort to attract FDI. By 1980, four special economic zones (SEZs) had been established in the southern coastal provinces of Guangdong and Fujian. The purpose of these SEZs was to adopt special policies and flexible measures to make full use of foreign investment and expand foreign trade. They were assigned a central role in the reform process as 'windows and bridges' to the outside world.

Nevertheless, investment flows during the initial stage of reform were low. In the four year period from 1979 to 1982, only 922 contracts were signed with a value of US$ 6.01 billion pledged, and a much lower amount of only US$ 1.166 billion foreign investment realised. This situation was partly the natural cautious reaction of foreign investors to a new market, and, more importantly, was closely related to China's lack of a necessary legal and institutional framework to accommodate FDI inflow. The Joint Venture Law consisted of only fifteen articles, thereby failing to serve as a clear guideline for negotiations. Clauses in each contract had to be negotiated on a case by case basis. The law also limited the access of joint ventures to the Chinese domestic market; made no provision for wholly foreign owned companies; required the Chairman of each joint venture to be Chinese; and put a finite life on all joint ventures following which ownership had to revert to the Chinese partner. Each foreign venture was required to maintain its own foreign exchange balances. Accompanying this, the non-convertibility of the Chinese currency meant that foreign enterprises generally had to export to cover their foreign exchange expense (Kamath 1990, 1994; Lardy 1994).

FDI did not begin to accelerate until the mid-1980s, following a variety of measures to improve the investment climate in China. From 1983, FDI inflow increased each year, and reaching a peak in 1985. Over three times as many contracts were signed in 1984 as in 1983, and in 1985 contracts increased a further 66 percent over the 1984 level. However, utilised FDI experienced a stable increase from 1983 to 1985, indicating that a large portion of contracted FDI was not actually realised.

Government policies contributing to the sharp increase of FDI during this period included the release of the 'Regulations for the Implementation of the Law on Joint Ventures Using Chinese and Foreign Investment' on September 20, 1983. This document included sixteen chapters and 118 articles, and was an important clarification and elaboration of the initial Joint Venture Law. In 1984, fourteen coastal cities were opened to foreign investors. In 1985, Yangtze River Delta, Pearl River Delta, and Minnan Delta were opened to FDI as economic development zones.

In these regions, FDI firms were exempted from import duties for equipment and materials used to establish the ventures and produce export goods. Foreign investment utilising advanced technology enjoyed further preferential treatment such as low income tax rates, and with a certain maximum percentage of products permitted to be sold in China. Local governments in these regions were given power to make decisions regarding FDI projects, and measures to improve basic infrastructure and simplify administrative procedures were implemented.

Compared with the sharp increase of contracted FDI in 1985, 1986 saw a 50 percent decrease in the number and value of contracted FDI projects. This situation was due to the realisation by foreign investors that despite the active policy measures, they still faced difficulties, such as underdeveloped infrastructure and an inefficient bureaucratic system. As well, the domestic market was still largely closed to products produced by enterprises with foreign direct investment.

As a result, the Chinese government promulgated various regulations to continue to improve the legislative framework. These include the 'Law on the Wholly Foreign Owned Ventures' passed on April 12, 1986, and the 'Law on the Contractual Joint Ventures' passed on April 14, 1988. The most important legislation during this period was the State Council's Provisions to Encourage Foreign Investment issued on October 11, 1986, known as the 'Twenty two Regulations'. These regulations increased foreign investors' autonomy in employment, reduced customs duties and excessive costs levied by local governments, and allowed for foreign exchange swaps. In July 1988, the government promulgated laws and regulations to encourage Taiwanese entrepreneurs to invest in mainland China. In 1990, an amendment to the 1979 joint venture law eased restrictions on aspects such as the initial limit on the duration of joint ventures and the appointment of Chairpersons to Boards. In May, 1990, the government enacted the 'Provisions on Encouraging the Investment of Overseas Chinese and Compatriots in Hong Kong, Macao, and Taiwan'. In September, the 'Provisions on Encouragement of Foreign Investment and Exemptions of Income Tax and Business Tax for Foreign-funded Enterprises in the Shanghai Pudong New Area' was approved. In October, China's Ministry of Foreign Trade and Economic Cooperation publicised the 'Detailed Regulations on the Implementation of the Law on Foreign Invested Enterprises' (Huang, 1995; Chen et. al. 1995).

These measures induced a continuous increase of FDI inflow from 1986 to 1990. In 1990, the number of contracted FDI projects increased to 7,273, nearly five times the 1986 level. The contractual investment value reached US$ 6.596 billion, more than double the 1986 level, and realised FDI rose to US$ 3.487 billion, an increase of more than 85 percent. There is no doubt that the 1990 level would have been higher without the 1989 Tiananmen Incident.

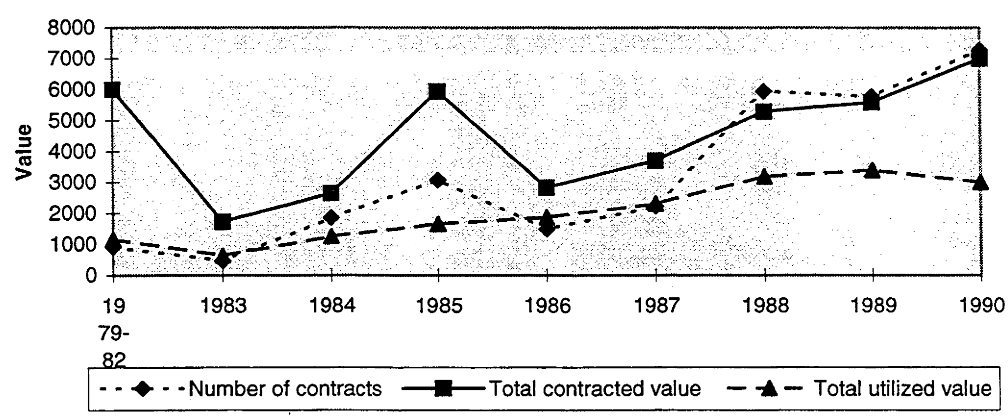
Beginning in 1991, FDI inflow jumped to a historic height and has continued to grow ever since. In 1991, contracted FDI reached over US$ 10 billion, almost double the 1990 level. However, realised FDI experienced a relatively modest increase of 25 percent. In 1992, the contracted value of FDI increased nearly five fold, while realised FDI more than doubled. This rapid expansion continued in 1993, with both the contracted and realised FDI inflow more than double the already very high level of 1992. By 1993, there were more than 80,000 foreign invested enterprises in China, with an accumulated foreign investment of US$ 61 billion. The dramatic surge of FDI in the 1990s dwarfed the FDI inflow of previous years (Figure 2.2, 2.3).

Table 2.1 Utilisation of foreign direct investment (US$ million)

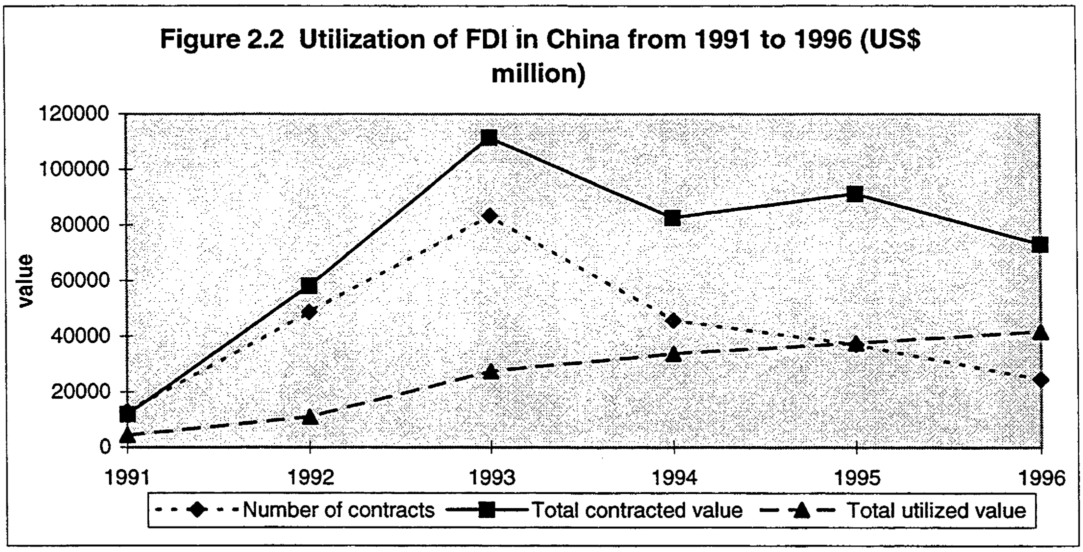
Year	Number of contracts	Total contracted value	Total utilised value
1979-82	922	6010	1166
1983	470	1732	636
1984	1856	2651	1258
1985	3073	5932	1661
1986	1498	2834	1874
1987	2233	3709	2314
1988	5945	5297	3194
1989	5779	5600	3392
1990	7273	6596	3487
1991	12978	11977	4366
1992	48764	58124	11007
1993	83437	111436	27515
1994	45749	82680	33767
1995	37011	91282	37521
1996	24556	73276	41726
Sum	281544	469540	174397

Sources: China Statistical Yearbook, various issues.

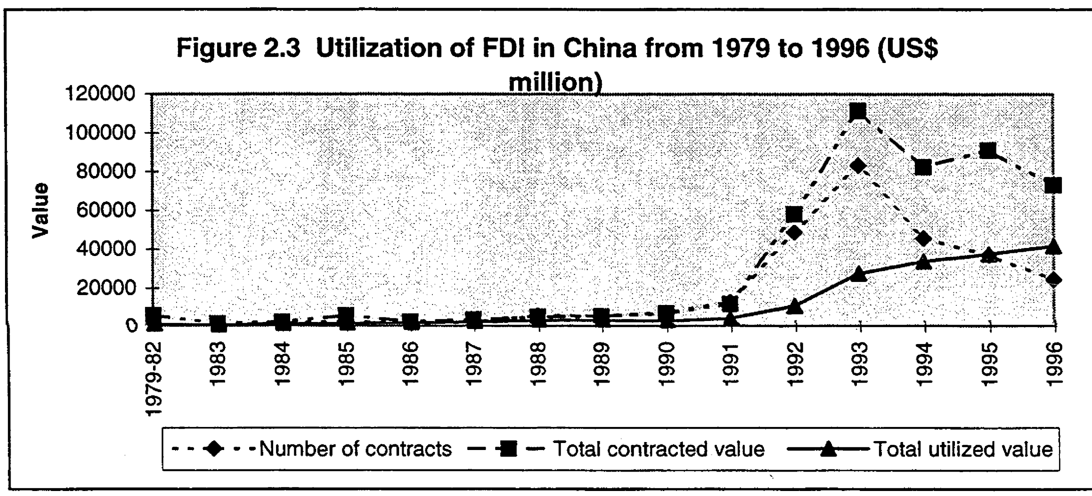
Figure 2.1 Utilization of FDI in China from 1979 to 1990 (US$ million)



Sources: China Statistical Yearbook, various issues.



Sources: China Statistical Yearbook, various issues.



Sources: China Statistical Yearbook, various issues.

One important factor which encouraged large amounts of FDI inflow was a speech made by Deng Xiaoping in 1992 when he carried out an inspection tour of the South, and called on China to emulate the successful economic development in South China. This greatly encouraged foreign investors to invest in China. China's political stability in the wake of the Tiananmen incident, combined with rapid growth of the domestic economy, led to a fundamental reassessment by foreign firms of China's economic and political potential (Lardy 1996). China also deepened liberalisation of its FDI regime. Starting in May 1990, foreigners were allowed to engage in the development and operation of land in Special Economic Zones and Coastal Open Zones. Manufacturing joint ventures were no longer required to include in their contracts the duration of the ventures. As well, provisions to attract FDI, such as special tax concessions, and liberalised land leasing, which in the late 1970s and early 1980s had only been available in the four special economic zones, were made available in a growing number of open coastal cities, economic development areas and high technology development zones (Lardy 1996).

Following the surge of FDI inflow from 1991 to 1993, the contracted value of FDI in 1994 showed a decrease, although the realised value of FDI continued to increase. In 1995 and 1996, while the number of contracts signed decreased, the contracted value continued to increase, and the realised value maintained the growing trend. This is because many large MNCs have begun to invest in China.

Many believe (e.g. Lardy 1994; Zhang and Tracy 1994) FDI inflow in China is overstated because some recorded FDI are in fact Chinese capital claiming to be foreign investment, in order to take advantage of the tax incentives provided to foreign invested firms. In these cases, some capital had first flown out and then returned to China, and some joint-ventures are established by local private companies and their overseas relatives, where the domestic partner invests capital, and their foreign relatives may merely invest their names. The World Bank estimated this could comprise as much as 25 percent of gross investment inflows in 1992 (Athukorala and Hill 1998). However, even when allowance is made for these investments, FDI in China still experienced impressive increases. From 1979 to 1996, China approved more than 280,000 foreign invested projects, resulting in a flow of US$ 174.4 billion of foreign capital. From 1990 to 1995, China was the world's fourth largest recipient (behind the USA, the UK, and France), and was by far the largest among developing countries, receiving 28 percent of total developing country FDI, (IMF: Balance of Payment Statistics Yearbook, various years).

Despite China's achievement in attracting FDI inflow, difficulties still prevail related to problems in basic infrastructure, the legal framework, property rights, inconvertible currency, policy inconsistencies, and corruption. This indicates that there is still potential for increased FDI inflow with further improvement of the investment environment.

2.2 The Changing Pattern of FDI in China

Alongside the changing size of FDI inflow is its changing composition, geographical location, sources, and industrial composition. These changes mark the distinctiveness of FDI and its development in China.

The composition of FDI has changed significantly over time. There are four types of FDI in China; namely, equity joint ventures, co-operative joint ventures, wholly foreign owned enterprises, and joint exploration. Data on these categories of FDI are summarised in Table 2.2.

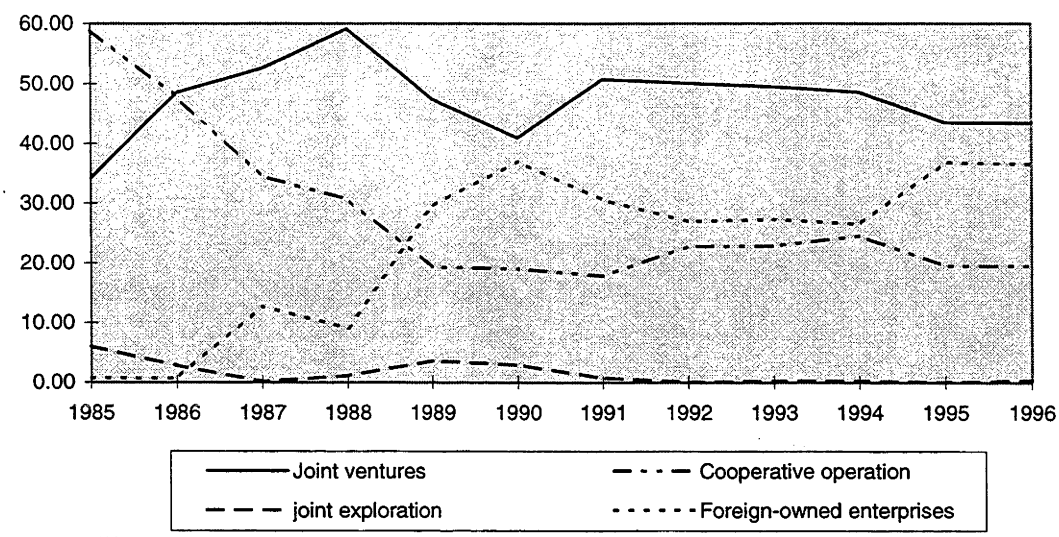
Table 2.2 Types of FDI in China

Year	Equity Joint Ventures		Co-operative Joint Venture		Joint Exploitation		Foreign Owned Firms	
	No. of contract	Value (US$ million)	No. of contract	Value (US$ million)	No. of contract	Value (US$ million)	No. of contract	Value (US$ million)
1985	1412	2029.7	1611	3496.2	4	359.6	46	45.7
1986	892	1375.2	582	1358.1	6	80.8	18	20.3
1987	1395	1950.4	789	1282.3	3	4.6	46	471.2
1988	3909	3133.9	1621	1623.9	5	58.6	410	480.6
1989	3659	2659.0	1179	1083.2	10	203.7	931	1653.8
1990	4091	2703.9	1317	1254.1	5	194.2	1860	2443.8
1991	8395	6080.0	1778	2138.0	10	920.	2795	3667.0
1992	34354	29129.0	5711	13256.0	10	43.0	8692	15696.0
1993	54003	55174.0	10445	25500.0	15	305.0	18975	30457.0
1994	27890	40193.5	6634	20300.9	18	236.6	13007	21948.6
1995	20455	39741.4	4787	17825.1	8	57.4	11761	33657.6
1996	12628	31876.4	2849	14296.9	17	292.7	9062	26810.3

Sources: China Statistical Yearbook, various issues.

Equity joint ventures refer to cooperation between Chinese and foreign firms based on capital contribution. The investment by foreign participants in an equity joint venture must be more than 25 percent of the total capital invested. In the case of a co-operative joint venture between a foreign partner and a Chinese firm, the two organisations remain separate in a corporate sense, and divide responsibilities and profit according to contract rather than on the basis of equity ratio. Under the co-operative joint venture, the foreign partner usually contributes capital, technology, and equipment, and the Chinese partner contributes labour, natural resources, and the production site. Wholly foreign owned enterprises are companies with equity invested solely from foreign entities (Kwon 1989). Joint development ventures refer mainly to off-shore petroleum exploration. This form of FDI was popular in the early 1980s, but has been declining in recent years.

Figure 2.4 The composition of FDI in China (%)



Sources: China Statistical Yearbook, various issues

Co-operative joint ventures were initially the major form of FDI in China, due to their flexibility, in that parties could freely negotiate the manner and proportions regarding profit or output distribution. However, equity joint ventures surpassed co-operative joint ventures in 1985 and have remained the highest proportion of FDI ever since. This reflects the changing preference of the Chinese government over investment form. No preferential treatment has been extended to co-operative joint ventures since 1984. The government considers equity joint ventures to be an effective method for transferring technology and management skills while assuring a significant level of government control. It is also often in the interest of the foreign investors to form a venture with a Chinese partner to reduce political risk. Although equity joint ventures have been the most popular form of FDI since the mid-1980s, constituting about half of the foreign capital directly invested, the growth of wholly foreign owned enterprises has been the most rapid in recent years. Before 1986, this form of investment was negligible. Since 1990, it has surpassed co-operative joint ventures as a form of foreign direct investment and accounted for the second largest share in terms of numbers of contracts and contracted value. The changing composition has shown that, firstly, government policies toward FDI have becoming increasingly liberalised, and secondly, foreign investors are more confident about investing in China.

Geographically, FDI is not evenly distributed in China (Table 2.3 and 2.4). In early years most FDI flowed to Southeast China, especially Guangdong province. In 1985, Guangdong accounted for nearly 50 percent of FDI inflow. Over time, the share of FDI to Guangdong province has declined. In 1995, only 27.75 percent of FDI inflow was to Guangdong, although it is still by far the largest destination for FDI in China.

In addition to Guangdong, foreign investment has been heavily concentrated in other South-eastern and Eastern coastal cities and provinces. In 1985, the province with the second largest FDI was Fujian, followed by Shanghai, Beijing, and Tianjin. In 1990, Liaoning province in Northeast China become the fourth largest destination, while Tianjin dropped to eleventh. This was because Liaoning opened some coastal cities, such as Dalian, thereby becoming an attractive destination. In 1995, Jiangsu and Shandong become the third and fifth largest destinations for FDI inflow, as these coastal provinces also opened up to foreign investors.

In the 1990s, FDI inflow has been spreading from coastal regions to some inland provinces such as Hubei, Hebei, and Sichuan. However, the more inland provinces, including Gansu, Qinhai, Ningxia, and Tibet, have not so far played important roles in attracting FDI inflow.

If the thirty provinces are divided into six regions, according to the official Chinese regional division criterion,[1] it is clear that FDI flow to South China dominated in 1985 and 1990. In 1995, however, the inflow to East China surpassed South China. The third largest region in terms of attracting FDI inflow was North China. Although FDI in inland provinces did increase, the inflow to Southwest China, and especially Northwest China was very low (Table2.4, Figure 2.5).

[1] These regions are: North China: Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia; Northeast: Liaoning, Jilin, and Heilongjiang; East China: Shanghai, Jiangsu, Anhui, Fujian, Jiangxi, and Shandong; South China: Henan, Hubei, Hunan, Guangdong, Guangxi, and Hainan; Southwest: Sichuan, Guizhou, Yunnan, Tibet; and Northwest: Shanxi, Gansu, Qinhai, Ningxia, and Xingjiang.

Table 2.3 Provincial distribution of FDI in China (US$ million)

	Provinces	1985	% in total	1990	% in total	1995	% in total
1	Beijing	88.82	6.80	276.95	8.76	1079.99	2.91
2	Tianjin	55.87	4.28	34.93	1.10	1520.93	4.09
3	Hebei	8.24	0.63	39.35	1.24	546.68	1.47
4	Shanxi	0.52	0.04	3.40	0.11	63.83	0.17
5	Inner Mongolia	2.62	0.20	10.64	0.34	57.81	0.16
6	Liaoning	24.58	1.88	243.73	7.71	1424.61	3.83
7	Jilin	4.87	0.37	17.60	0.56	408.02	1.10
8	Heilongjiang	3.95	0.30	24.49	0.77	516.86	1.39
9	Shanghai	107.54	8.23	174.01	5.50	2892.61	7.78
10	Jiangsu	33.47	2.56	124.16	3.93	5190.82	13.97
11	Zhejiang	26.63	2.04	48.43	1.53	1258.06	3.39
12	Anhui	3.03	0.23	9.61	0.30	482.56	1.30
13	Fujian	118.60	9.08	290.02	9.17	4043.90	10.88
14	Jiangxi	10.49	0.80	6.21	0.20	288.88	0.78
15	shandong	35.63	2.73	150.84	4.77	2688.98	7.24
16	Henan	8.27	0.63	10.49	0.33	478.55	1.29
17	Hubei	8.00	0.61	29.00	0.92	625.12	1.68
18	Hunan	27.28	2.09	11.16	0.35	507.73	1.37
19	Guangdong	651.31	49.84	1460.00	46.16	10260.11	27.61
20	Guangxi	30.73	2.35	28.66	0.91	672.63	1.81
21	Hainan	0.00	0.00	103.02	3.26	1062.07	2.86
22	Sichuan	28.72	2.20	16.04	0.51	541.59	1.46
23	Guizhou	9.78	0.75	4.68	0.15	57.03	0.15
24	Yunnan	1.63	0.12	2.61	0.08	97.69	0.26
25	Tibet	0.00	0.00	0.00	0.00	0.00	0.00
26	Shanxi	15.55	1.19	41.91	1.32	324.07	0.87
27	Gansu	0.57	0.04	0.85	0.03	63.92	0.17
28	Qinhai	0.00	0.00	0.00	0.00	1.64	0.00
29	Ningxia	0.00	0.00	0.25	0.01	3.90	0.01
30	Xingjiang	0.00	0.00	5.37	0.17	54.90	0.15
sum		1306.70	100.00	3163.04	100.00	37160.59	100.00

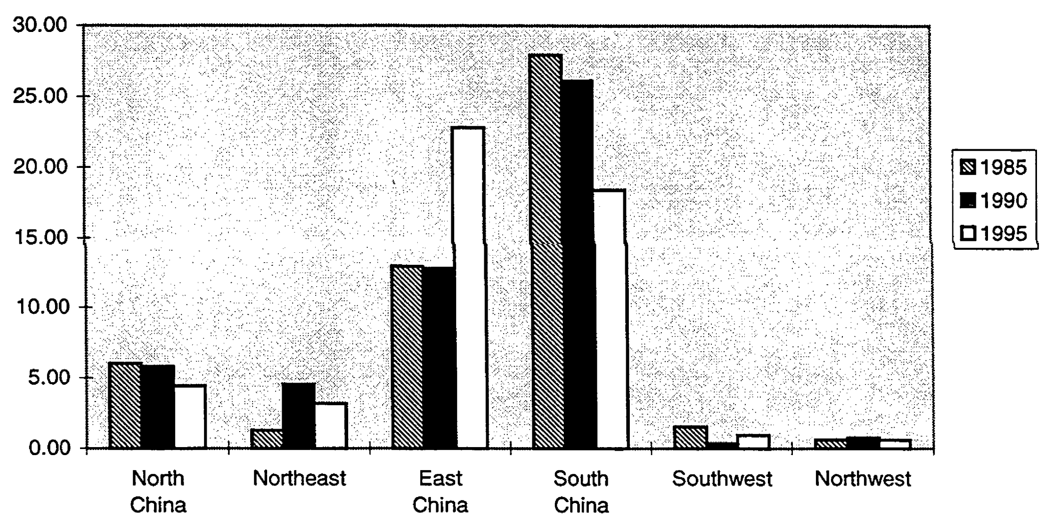
Sources: China Statistical Yearbook, various issues.

Table 2.4 Regional distribution of FDI in China

	Contracted Value (US$ million)			% of total		
Regions	1985	1990	1995	1985	1990	1995
North China	156.07	365.27	3269.24	6.01	5.81	4.42
Northeast	33.40	285.82	2349.49	1.29	4.55	3.18
East China	335.39	803.28	16845.81	12.91	12.78	22.79
South China	725.59	1642.33	13606.21	27.94	26.14	18.40
Southwest	40.13	23.33	696.31	1.55	0.37	0.94
Northwest	16.12	48.38	448.43	0.62	0.77	0.61

Sources: China Statistical Yearbook, various issues.

Figure 2.5 The regional distribution of FDI in China (% of total)



Sources: China Statistical Yearbook, various issues.

Various factors have been proposed to explain the geographical pattern of FDI in China. The government's preferential treatment offered to foreign investors in different areas has no doubt contributed to the uneven distribution of FDI in China. Since the initiation of economic reform, the government has adopted an incremental approach in implementing the 'open-door' policy. The earliest areas opened to foreign investors were the Four Special Economic Zones in Guangdong and Fujian provinces in 1980. Gradually, more regions were given autonomy and incentives to attract FDI. In 1984, the government designated fourteen open coastal cities and development zones.[2] Subsequently, three 'Development Triangles' - the Yangtze River Delta, the Pearl River Delta, and the Minnan Region were opened to foreign investors in 1985. The Hainan Island Special Economic Zone was formed in the same year. After 1987, most coastal cities engaged in inducing FDI by offering preferential treatment. In 1989, the concept of SEZ was extended to the Shanghai Pudong New Development Area. Since 1990, most provincial capital cities have been open to FDI. The close geographical and cultural links between South China and overseas Chinese communities is also a factor explaining the concentration of FDI in South China. More importantly, the lack of basic infrastructure and poor development of inland China, in terms of both human capital and physical capital conditions add costs to foreign investment and impede the inflow of FDI to these areas.

The importance of the investing countries and regions in China is also changing over time. In 1985, Hong Kong,[3] the United States, Japan, the United Kingdom, France and Germany were the most important investors. Hong Kong accounted for 51.6 percent of the total realised amount of FDI pledged. The US and Japan trailed behind with 19.28 and 17.01 percent, respectively. All other countries and regions each accounted for less than 4 percent of FDI. In 1990, Hong Kong still dominated as a source of FDI, while Japan had become the second largest investing country, followed by the United States. Due to the regulations released in 1988 encouraging Taiwanese entrepreneurs to invest in mainland China, Taiwan was the fourth most important investor. Germany and Singapore were the fifth and sixth investing countries. The rest of all countries each accounted for less than 1 percent of realised FDI. In 1995, the largest investor was still Hong Kong, with Japan ranked second, followed by Taiwan, and the United States. Singapore was next accounting for over 5 percent of total FDI in China, with South Korea, the United Kingdom, Macao, and Germany each taking more than one percent of the total FDI pledged.

It is clear from Table 2.5, that the largest amount of FDI in China has come from people of Chinese background. Hong Kong was to the forefront in this regard, accounting for 50 percent of FDI throughout the years. The relative importance of

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[2]These cities are: Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang, and Beihai.

[3] After 1997, it is in the realm of semantics as to whether investment from Hong Kong can still be regarded as foreign.

overseas Chinese from other regions and countries, such as Taiwan and Singapore, has been increasing over the years. Among the developed countries, Japan has been the most important investor, while the relative importance of the United States was more significant in the earlier years. The share of FDI from Germany was fairly stable, Britain's share has fluctuated from year to year, while that of France has decreased.

Table 2.5 The major sources of foreign direct investment in China (US$ million, %)

Ranks	Countries	1985	1985	Countries	1990	1990	Countries	1995	1995
		values	% in total		values	% in total		values	% in total
1	Hong Kong	95568	51.60	Hong Kong	191342	56.61	Hong Kong	2018511	54.46
2	United States	35719	19.28	Japan	50338	14.89	Japan	321247	8.67
3	Japan	31507	17.01	United States	45599	13.49	Taiwan	316516	8.54
4	United Kingdom	7135	3.85	Taiwan	22240	6.58	United States	308373	8.32
5	France	3254	1.76	Germany	6425	1.90	Singapore	186061	5.02
6	Germany	2414	1.30	Singapore	5043	1.49	South Korea	104710	2.83
7	Italy	1938	1.05	Australia	2487	0.74	United Kingdom	91520	2.47
8	Australia	1436	0.78	Kuwait	2400	0.71	Macao	43982	1.19
9	Singapore	1013	0.55	France	2106	0.62	Germany	39053	1.05
10	Canada	940	0.51	The Netherlands	1598	0.47	Virgin Islands	30376	0.82
11	Thailand	884	0.48	United Kingdom	1333	0.39	Thailand	28824	0.78
12	Brazil	793	0.43	Denmark	1039	0.31	France	28702	0.77
13	Belgium	789	0.43	New Zealand	888	0.26	Italy	27020	0.73
14	Denmark	646	0.35	Canada	804	0.24	Malaysia	25900	0.70
15	Sweden	357	0.19	Belgium	800	0.24	Canada	25704	0.69
16	Philippines	311	0.17	Spain	725	0.21	Australia	23299	0.63
17	Spain	265	0.14	Panama	676	0.20	The Netherlands	11411	0.31
18	Kuwait	200	0.11	Thailand	672	0.20	Indonesia	11163	0.30
19	Malaysia	25	0.01	Italy	410	0.12	Bermuda	10914	0.29
20	The Netherlands	13	0.01	Norway	223	0.07	Philippines	10578	0.29

Source: Almanac of China's Foreign Economic Relations and Trade, various issues.

Despite the changes in the relative importance for each country, the absolute value of FDI pledged from most investing countries has been increasing over time. More and more countries have been engaging in investing in China. In 1985, only about 23 countries and regions had invested in China, by 1995, over 50 countries and regions had pledged investment in China. These contributed to the rapid increase of FDI inflow in China.

FDI is not evenly distributed among industries. A large share of FDI in the early years was in real estate and tourism related projects. In 1995, real estate was still a large sector in attracting FDI. There has been relatively low levels of FDI in sectors such as transportation and telecommunications, and scientific research and technical services (Table 2.6). These sectors are considered to be important industries for developing China as a industrialised economy. In this regard, the sectoral distribution of FDI has been disappointing for the government.

Table 2.6 Contracted foreign direct investment by section

Sectors	1985		1989		1995	
	(million US$)	%	(million US$)	%	(million US$)	%
Agricultural, Forestry, Husbandry, and Fishing	126.31	1.99	121.38	2.17	1735.78	1.90
Manufacturing	2384.23	37.65	4663.66	83.28	61647.63	67.54
Geological Prospecting	362.09	5.72	0	0.00	11.63	0.01
Construction	132.52	2.09	66.95	1.20	1918.36	2.10
Transportation and Communication	105.68	1.67	52.11	0.93	1696.98	1.86
Tourism	526.54	8.31	67.35	1.20	3426.65	3.75
Real Estate and Public services	2270.58	35.85	523.79	9.35	17835.42	19.54
Hygiene, Sports, and Social Welfare Services	51.52	0.81	35.64	0.64	837.41	0.92
Education, Cultural, and Art	4.26	0.07	7.23	0.13	344.96	0.38
Scientific Research and Technical Service	6.63	0.10	3.59	0.06	277.75	0.30
Finance and Insurance	63.1	1.00	0	0.00	54.07	0.06
Others	299.75	4.73	58.06	1.04	1494.89	1.64

Sources: Almanac of China's Foreign Economic Relations and Trade, various issues.

Since the late 1980s, manufacturing has become the most important sector in attracting FDI. In 1995, it made up 67.54 percent of FDI, nearly double the level in 1985. In the manufacturing sector, industries with the highest number of foreign invested firms are garments, textiles, electronics, plastic manufacturing, construction materials, food, leather, fur, down and related products. FDI in these industries accounts for 70 percent of the total in China (Table 2.7). The promotion of capital and technology intensive industries has been one of the government's priorities since 1979. Given that FDI is mainly distributed in labour intensive industries, a prevailing idea is that FDI has not fully met expectations regarding transferring technology (Freeman 1994; Li and Su 1996).

Table 2.7 Industrial distribution of FDI in China (1995)

Industries	No. of firms	No. of firms in total (%)
food processing	1893.00	4.08
food manufacturing	1909.00	4.11
beverage manufacturing	1202.00	2.59
tobacco processing	10.00	0.02
textile industry	4218.00	9.09
garment and other fibre products	5965.00	12.86
leather, furs, down, and related products	2513.00	5.42
timber processing, bamboo, cane, palm fibre and straw products	1270.00	2.74
furniture manufacturing	741.00	1.60
paper-making and paper products	1079.00	2.33
printing and record pressing	860.00	1.85
cultural, educational, and sports articles	1188.00	2.56
petroleum processing and coking products	133.00	0.29
raw chemical materials and chemical products	2625.00	5.66
medical and pharmaceutical products	868.00	1.87
chemical fibres	363.00	0.78
rubber products	470.00	1.01
plastic products	3038.00	6.55
non-metal mineral products	2548.00	5.49
smelting and processing of ferrous metals	380.00	0.82
smelting and processing of non-ferrous metals	459.00	0.99
metal products	2371.00	5.11
ordinary machinery manufacturing	1450.00	3.13
special purposes equipment manufacturing	1303.00	2.81
transportation equipment manufacturing	1409.00	3.04
electric equipment and machinery	2230.00	4.81
electronic and telecommunications	2900.00	6.25
instruments, meters, cultural and office machinery	999.00	2.15
Total	46394.00	100.00

Source: China Statistical Yearbook (1996)

2.3 Conclusions

Since the initiation of economic reform in 1978, the Chinese government has implemented a series of measures to induce FDI inflow to China. Efforts were made to enact laws and regulations regarding foreign direct investment in various aspects such as taxation, employment, and investment duration. This resulted in a rapid inflow of FDI in China. From 1990 to 1995, China was the fourth largest recipient of FDI in the world and by far the largest among developing countries.

Reflecting China's increasingly liberal FDI policies and the growing confidence of foreign investors, equity joint ventures and wholly foreign owned enterprises have replaced co-operative joint ventures as the leading form of investment. Geographically, more and more provinces, including some inland provinces, have become attractive destinations for FDI in China, despite the fact that FDI is still concentrated in the Southeast and East coastal regions. The number of countries investing in China has been increasing over time, together with the increased value of investment from most of the investing countries. However, over 50 percent of investment is still from overseas Chinese communities. In terms of industrial distribution of FDI in China, in recent years manufacturing has surpassed real estate and tourism related projects to become the largest sector for FDI. However, most investment is still concentrated in labour intensive industries. The concentration of FDI in labour intensive industries was considered disappointing in regard to meeting the official objective of transferring advanced technology into China.

It is commonly recognised that FDI has contributed to China's economic development in a varieties of ways. By the mid-1990s, FDI accounted for over 12 percent of total gross domestic capital formation. This has greatly alleviated the demand for external loans. In 1995, enterprises with FDI generated over US$ 10 billion of tax revenue. There were more than 5,500,000 people employed in FDI firms. The inflow of FDI has also enhanced interaction between China and other countries. The export share of foreign invested firms reached 31.5 percent in 1995, and increased to 40.7 in 1996. However, more controversy exists regarding the evaluation of the role of FDI in transferring technology and promoting growth in China. Given that one of the most important motivations for the government to attract FDI inflow was and still is to improve China's overall technology level, a careful study of the relationship between FDI, technology spillover, and growth in China is needed.

Chapter 3

Spillovers from Foreign Direct Investment - A Survey of the Literature

This chapter surveys the literature on foreign direct investment (FDI) inflow and spillover effects in order to provide background for the analysis that follows, to identify missing aspects in previous studies, and to highlight the need for this study. The survey begins with an examination of theoretical studies on spillover effects, followed by the empirical evidence of spillover effects and the study of FDI in China.

3.1 Theoretical Studies of the Spillover Effect

The role of FDI in bringing in technology had long been ignored in the orthodox literature. The standard neoclassical trade theory of Heckscher and Ohlin, with its restrictive assumptions of international immobility of factors of production and identical production functions across nations, considered no international difference existed at scientific and technological levels, not to mention technology transfer. In the neoclassical financial theory of portfolio flows, multinational enterprises had been viewed as simply an arbitrageur of capital in response to changes in interest rate differentials. Capital flows from countries where returns are low to those where it is higher to earn arbitrage rents. This theory did not distinguish between the roles played in a country's development by portfolio and FDI capital inflows (Dunning and Rayman 1985; Teece 1985).

It was not until the pioneering work of Hymer (1976) that attention was focused on multinational companies (MNCs). Hymer's great contribution was to shift away from the neoclassical financial theory. In his view, FDI is more than a process by which assets are changed internationally. It means international production. By putting forward the idea that FDI represents not simply a transfer of capital, but the transfer of a 'package' in which capital, management, and new technology are all combined, Hymer characterised FDI as an international extension of industrial organisation theory.

The industrial organisation theory of FDI was extended by Caves (1971, 1974) and Kindleberger (1984). The theory emphasises the behaviour of firms that deviate from imperfect competition ideals as the determinants of FDI. It realises that for a firm to undertake FDI in a foreign country, it must possess some special advantage over potential domestic competitors. Technological superiority or possession of some intangible, rent-yielding assets, is believed to provide such an advantage. Viewed this way, FDI involves a transfer of intangible assets such as technological skills across nations. Neglect of this technological aspect can lead to a serious underestimation of the role of foreign owned capital in the recipient country. However, early theorists neither calculated the benefits and costs of technology transfer, nor analysed explicitly the impact on a host country of spillover effects.

An explicit model analysing FDI and technology did not appear until the late 1970s. Koizumi and Kopecky (1977) were the first to explicitly model FDI and technology transfer. They used a partial equilibrium framework to analyse technology transfer from a parent firm to its subsidiary. Technology transfer was introduced by assuming it was an increasing function of the country's capital stock owned by foreign residents. The transmission of foreign technology was viewed as "automatic" and technology was treated as a public good. The results showed that two countries with identical production functions could follow different time paths and reach different steady state equilibrium. The analysis implied that an increase in a country's savings ratio would reduce foreign capital and, through its effect on technical efficiency, reduce its steady state capital intensity.

Findlay (1978) constructed a model to examine the relationship between FDI and technological change in a backward region. The rate of technological progress in the advanced region was postulated to increase at a constant rate. The rate of technological diffusion to the backward country is assumed to depend on two factors. First, following the hypothesis of Gerschenkron (1962), which states that the greater the relative disparity in development levels between the backward country and the industrialised part of the world, the faster the catch up rate, Findlay puts forward the hypothesis that the rate of technological progress in a 'backward' region is an increasing function of the technology gap between it and the 'advanced' region. Therefore, for a given amount of foreign presence, the larger the technology gap between the foreign and domestic firms, the larger the spillovers. Second, Findlay followed Arrow (1971), to consider technology diffusion as analogous to the spread of a contagious disease. Therefore, technological innovations are most efficiently diffused when there is personal contact between those with the knowledge of the innovation and those who adopt it.

These considerations lead to the hypothesis that the ratio of technical change in the backward region is an increasing function of the extent to which it opens up to FDI. The ratio of capital stock of the foreign owned firms in the backward region to the capital stock of the domestically owned firms was used to measure the extent of foreign penetration. Findlay then considered the determinations of the relative growth rates of foreign and domestic capital. He showed the effect of changes in various parameters in the steady state, such as the backward region's saving propensity and the tax rate of foreign profit on the 'backward' region's degree of 'dependency' on foreign capital. However, the model did not provide any explanation for the forces that determine the transfer of technology from the foreign to domestic firms.

Das (1987) utilises a price-leadership model in the oligopoly theory to analyse the transfer of technology from the parent firm to its subsidiary abroad. This analysis recognises that the domestic firms learn from the MNCs and become more efficient. This increase in efficiency of domestic firms is costless and exogenous to them. It is also assumed that the rate of increase in efficiency of the native firm is positively related to the level of activities of the MNC's subsidiary. The larger the scale of operation, the greater the opportunity for the native firm to learn from it. He then models the choice problem for the MNC due to the cost imposed from the 'learning from watching' by the native firm. Along the optimal path, he concludes that the MNC benefits from the technology transfer from its parent company in spite of the leakage of knowledge in the host country. However, the effect on profit and output of the native firm is ambiguous, and the host country benefits unambiguously. Therefore in spite of the loss to the MNC due to learning by the native firm, it is still worthwhile for the MNC to import better technology. This model recognises that the MNC affiliates are aware of the technology leakage, and determines technology transfer behaviour based on this recognition. Yet, the behaviour of the local firm is still not explicitly taken into account.

Wang and Blomstrom (1992) developed a model in which international technology transfer through MNCs emerges as an endogenised equilibrium phenomenon resulting from the interaction between a foreign subsidiary and a host country firm. They also follow Findlay's assumption of a positive relationship between the technology gap and spillovers. However, the model recognises the cost of transferring technology within MNCs and the learning cost of host country firms. Since both the foreign subsidiary and the indigenous firm can make their own investment decisions to maximise profit, there is strategic interaction between them, where both firms solve their individual dynamic optimisation problems subject to the other's actions in a game theoretic context. The model merits a careful analysis since the conclusions from the it have important policy implications.

Wang and Blomstrom start by assuming that technology affects demand. Consumers' preference is represented by the utility function

$$(3.1) \quad U(Y) = U(\textstyle\sum_i G_i Y_i),$$

where Y is an industry output index, Y_i is firm i's output, and the weight G_i reflect the attractiveness of firm i's products. G_i increases with firm's technology level K_i. Moreover, they assume the utility function is logarithmic, and $G_i(K_i)$ is of the form K_i^a, where a is a positive constant. Then, $U(Y)$ can be expressed as

$$\begin{aligned}(3.2) \quad U(Y) &= U(K_d^a Y_d + K_f^a Y_f) \\ &= U(K_d^a (Y_d + (K_f^a / K_d^a) Y_f),\end{aligned}$$

and a monotonic transformation also means that the utility function can take the following form:

$$(3.2') \quad U(Y) = aLnK_d + Ln(Y_d + k^a Y_f),$$

where k is the technology gap, defined as the ratio of the foreign firm's technology level to that of the local firm, and subscript d and f refer to domestic and foreign, respectively.

The price of each product is set proportional to its marginal utility in equilibrium, and setting the marginal utility of money equals to 1, it follows from (3.2′) that the prices facing the local and foreign firms are

$$(3.3) \quad P_d(k,Y_d,Y_f) = \partial U(Y) / \partial Y_d = (Y_d + k^a Y_f)^{-1},$$

and

$$(3.4) \quad P_f(k,Y_d,Y_f) = \partial U(Y) / \partial Y_f = k^a (Y_d + k^a Y_f)^{-1}.$$

These equations show that the prices for both firms' products depend on the quantities of both goods and on the relative attractiveness of the products, which is determined by the technology gap between the two firms. It can also be shown that

$$(3.5) \quad \partial Pd / \partial k = (-ak^{(a-1)} Y_f) / (Y_d + k^a Y_f)^2 < 0,$$

but

$$(3.6) \quad \partial P_f / \partial k = (ak^{(a-1)} Y_d) / (Y_d + k^a Y_f)^2 > 0.$$

That is, the prices of the MNC affiliate's products increase with the technology gap, whereas the price of the local firm's product moves in the opposite direction.

Wang and Blomstrom break down each firm's decision into two steps. Each firm chooses its output to maximise its monopoly profit, given the status quo of both firms' technological level and its competitor's current output. Intertemporally, each firm chooses its technology investment to maximise the present value of its profit stream.

The quasi-rent function of firm i, given P_i as above, is then

$$(3.7) \quad R_i(k) = \underset{Y_i}{Max}\{P_i(k,Y_{i,}Y_j^*)Y_i - \bar{c}_i Y_i | Y_i \ is \, feasible\},$$

where $\bar{c}_i$ is the firm's marginal cost, and Y_j^* is the Cournot-Nash equilibrium output of the other firm.

It is assumed that the MNC affiliates can increase technological levels K_f by investing resources I_f to import technology from its parent company. The speed of the technology transfer is proportional to the MNC's commitment to the transferring activity. For simplicity, the marginal productivity of I_f is assumed to be constant and equal to 1. Hence, (3.8) $DK_f = I_f K_f$,

where D marks the time derivative, that is $DK_f = dK_f / dt$. The local firm's technological development is expressed as

$$(3.9) \quad DK_d = f(I_d)kK_d, \qquad \text{with}$$
$$f' > 0, \quad f'' < 0, \quad f(0) = v > 0$$

where the constant v is the rate of costless technology spillovers. The technological level of the local firm increases in response to its learning investment I_d, and the return of the investment diminishes as the learning effort increases. The technological progress of the local firm is an increasing function of the technology gap, following the hypothesis by Findlay (1978).

Equations (3.8) and (3.9) taken together define the changes in the technology gap:

$$\begin{aligned}(3.10) \quad Dk &= D(K_f / K_d) \\ &= (K_d * DK_f - K_f * DK_d) / K_d^2 \\ &= (K_d I_f K_f - K_f * f(I_d) kK_d) / K_d{}^2) \\ &= (I_f - f(I_d)k)k.\end{aligned}$$

The foreign firm's objective is to choose $I_{f(t)}$ to maximise the discounted value of its profit stream subject to the transfer absorption process, given the learning effort of the domestic firm. The dynamic optimisation problem involves a trade-off between current and future profit.

$$\begin{aligned}(3.11) \quad & \max V^f = \int_0^\infty e^{-rt}(R_f(k) - C_f(I_f))dt \\ & s.t. \quad Dk = (I_f - f(I_d k))k,\end{aligned}$$

where r is the discount rate used by the MNC affiliate, $R_f(k)$ is the quasi-rent function, $C_f(I_f)$ is the cost for technology transfer, and C_f is assumed to be strictly convex in I_f.

Analogously, the domestic firm faces the problem of choosing I_d subject to equation (10) and given the choices of the affiliates. That yields the function

$$\begin{aligned}(3.12) \quad & \max V^d = \int_0^\infty e^{-\rho t}(R_d(k) - \theta\, C_d(I_d))dt \\ & s.t. \quad Dk = (I_f - f(I_d k))k,\end{aligned}$$

where C_d is the domestic firm's learning cost, it is assumed to be strictly convex in I_d, ρ is the domestic firm's discount rate, and θ is a shifting parameter representing the cost efficiency of the firm's learning investment. The smaller is θ, the more cost effective the domestic firm's learning activities.

Equations (3.11) and (3.12) describe a differential game that can be solved by defining the steady-state equilibrium conditions for each firm's optimal control problem, given the decisions of the other player. By solving this dynamic optimisation problem, Wang and Blomstrom found that:

- Technology transfer from a parent company to a subsidiary is positively related to the level of domestic firm's learning investment.
- Technology transfer from a parent company to a subsidiary is positively related to cost efficiency of the domestic firm's learning investment.
- The lower the domestic firm's discount rate, the more rapid the technology transfer. The higher the operation risks - for example, political instability or low potential economic growth - the more reluctant foreign firms will be to transfer technology.
- Some technology transfer proportional to the size of the technology gap always take place irrespective of the local firm's active learning effort. The more costless the technology spillovers from foreign to domestic firms, the faster the technology transfer.

In the models of Koizumi and Kopecky (1977), Findlay (1978), and Das (1987), the superior technology possessed by foreign firms is considered to be a 'public good' in nature, and transferred automatically. However, the growing importance of international patent agreements and licensing of technology suggests that technological knowledge is frequently a private rather than a public good, and technology can rarely be automatically transferred. The contribution of Wang and Blomstrom's model lies in its highlight of the essential role played by competing host country firms in increasing the rate at which MNCs transfer technology. Both the MNC affiliate and the local firm are able to influence the extent of the technology transfer through their investment decisions.

However, some common problems exist for these models. In reality, there are two facets in international technology transfer. One is technology transfer from the parent firm of a MNC to its subsidiary abroad. The second is technology transfer in the form of an externality from the subsidiary to native firms in the host country. Through recognised by some (Das, 1987, Wang and Blomstrom, 1992), all the models focus on technology transfer from a MNC to its own subsidiaries. Technology transfer from a subsidiary to domestic firms is taken for granted. In these models, a host country's production efficiency is formulated as an increasing function of the presence of foreign capital.

The assumption of Gerschenkron (1962), which suggests the wider the technology gap between the developed and developing country, the larger the potential for technological imitation, is incorporated in all these models. To date, there remains ample scope for experiment and debate about the framework within which to analyse the relationship between the technological gap and the spillover effect. More and more evidence, however, shows that the assumption that technology transfers increase with a larger technology gap is not valid. For example, the dynamic game-theoretic model developed by Cheng (1984) shows a change of technological leadership is more likely to occur where the initial technological disparity was small.

The effect of FDI on growth is also modelled in the growth theory framework. In traditional neoclassical growth models of the Solow (1956) type, with the diminishing returns to physical capital, and technological change being exogenous, FDI cannot affect the long run growth rate. In the absence of international factor mobility, these theories predict that countries with the same preferences and technology will converge to identical levels of income and asymptotic growth rate. Factor mobility reinforces this prediction. Capital will flow from capital abundant countries to where it is scarce. The long run equilibrium is characterised by the identical equalisation of capital labour ratios and factor prices (Wang 1990b).

The new growth theories that have emerged since the mid-1980s have shifted attention away from the earlier neoclassical modelling. Whereas the neoclassical theory treated technological progress as an exogenous process and focused on capital accumulation as the main source of growth, the new growth theory has focused on issues relating to the creation of technological knowledge and its transmission. It views innovations and imitation efforts that respond to economic incentives as a major engine of growth. Therefore, it emphasises the role of R&D, human capital accumulation, and externalities (Grossman and Helpman 1991; Lucas 1988; Romer 1990).

For a similar reason, technology transfer through trade has become a popular area of research (Krugman 1979). However, the fact that the interrelationship between FDI and growth has not been the subject of intensive studies is a surprising omission in light of the apparent empirical importance of the relationship. Externalities and their impact on long run growth has been a common element in endogenous growth models. It is widely recognised that FDI is a composite bundle of capital stocks, know-how and technology. In this sense, FDI can lead to increasing returns to scale in domestic production through spillovers. The advent of endogenous growth theory has focused research into the channels through which FDI can be expected to promote long run growth.

While primarily dealing with international diffusion associated with trade in goods, Helpman (1993) discusses briefly the implication of international capital movements in the context of endogenous growth, focusing on how economies of scale interact with free capital movements. He observes that there may be agglomeration effects in capital accumulation in models where the externality comes from the capital stock. Technology transfer along with foreign investment is an explicit element in Helpman's discussion. This is done in a rather crude manner in that MNCs and producers in developing countries are identical. Therefore Helpman (1993) stresses the need for a more thorough treatment of MNCs with respect to growth.

In one of the few exceptions to deal with FDI and growth, Wang (1990b) builds a dynamic two country model to study the interaction between growth and international capital movement. Perfect capital mobility links the two regions. Human capital plays an important role in determining the effective rate of return for physical capital and hence affects the direction and magnitude of international capital movements. The analysis again treats FDI by incorporating Gerschenkron's (1962) hypothesis on technology transfer, in that the rate of technological change in a less developed country is considered to be an increasing function of the amount of foreign capital operating there. With capital already moving internationally, the model predicts that the steady-state income gap is narrowed by an increase in the growth rate of human capital and the technology diffusion rate in the less developed country (LDC). One of the messages emerging from the analysis is that opening to FDI from more advanced countries has important beneficial implications for a developing country. Foreign investment facilitates domestic technological change, and hence increases the rate of income growth.

Walz (1997) incorporates FDI into an endogenous growth framework where MNCs play a critical role with respect to growth and specialisation patterns. He extracts the idea of trade related international knowledge spillovers used in Grossman and Helpman (1991) to FDI. Production activities of MNCs in the low-wage country improve the efficiency of potential innovations there. The knowledge spillover of MNCs' activities makes innovation in the low wage country profitable. Allowing for imitation in the less developed country, the indirect transfer of technology through FDI provides the stimulus for active R&D and growth. Therefore, he predicts that policies promoting FDI lead to faster growth.

These models in the growth theory framework also focus primarily on technology transfer from the parent companies to subsidiaries. Technology spillover from a MNC subsidiary to domestic firms is assumed to be proportional to the presence of FDI in the host country. While this sort of simple epidemic diffusion model offers advantages in allowing one to relate the speed of diffusion to the amount of FDI inflow, criticism can be made of the implicit assumptions that technology spillover from a subsidiary to domestic firms is automatic.

3.2 Empirical Studies of Spillovers

3.2.1 Previous Empirical Studies

Compared with the relatively small number of theoretical models, there is a rich body of empirical studies. Most early studies were directed to individual spillover channels. Gershenberg (1987), Lim and Fong (1982), Mansfield and Romeo (1980), and Rhee and Belot (1990) are a few examples of these. These studies present mixed evidence on the role of foreign investment in generating technology transfer to domestic firms. In Mauritius and Bangladesh, the study of Rhee and Belot (1990) suggests that the entry of foreign firms led to the creation of a booming domestic textiles industry. However, in a survey of 15 multinationals, Mansfield and Romeo (1980) found that only a small share of FDI had accelerated the local competitors' access to new technology.

Studies employing econometric models to investigate the relationship between FDI and productivity started to appear in the early 1970s, where spillovers were considered to exist if a positive correlation between productivity and FDI was found. The dependent variable in these models was generally labour productivity. The explanatory variables in these models included FDI, factor input, the concentration ratio, and labour quality.

The earliest analysis using econometric analysis was conducted by Caves (1974) testing the spillover benefits of FDI in the manufacturing sectors of Canada and Australia. The hypothesis for Canada is that if FDI has the virtue of increasing allocative efficiency, the profit rate of domestic firms should be inversely related to the competitive pressure supplied by foreign firms. The results indicate that profit in Canadian manufacturing industries did show a weak tendency to vary inversely with the foreign share. The 1966 data for 23 manufacturing industries enabled Caves to test the determinants of value-added per worker in the domestic sectors of Australian industries. Proxying the foreign presence by the foreign firms' share of industry employment, Caves found that the higher the subsidiary share the higher the productivity level in competing domestic firms. The results support the hypothesis that spillovers are present.

Using the annual census data for four digit Canadian manufacturing industries in 1972, Globerman (1979) replicated the finding of Caves (1974). The dependent variable was defined as the ratio of total value added per employee in domestically owned manufacturing plants. The explanatory variables aim to take into account factors that may influence labour productivity, including the foreign share of the industry, differences in the capital labour ratio between Canadian and comparable U.S. industries, differences in labour quality measured by wage per worker in the affiliates and, alternatively, the share of male employees with tertiary education, and scale economies measured by average plant size related to the minimum efficiency scale in the U.S. The FDI variable is measured by the gross book value of depreciable assets at the end of 1971, divided by the total employees in 1972, in U.S. industries. The results also provided support for the proposition that the spillover efficiency benefits domestic firms.

Most of the empirical studies about developing countries use data from Mexico which gathers manufacturing data by ownership type. For example, Blomstrom and Persson (1983) used data for 215 four digit Mexican industries from the 1970 census to carry out the analysis. They also take labour productivity as a measure of technological efficiency. They related this to capital intensity, labour quality measured by the ratio of white-collar to blue-collar workers, economies of scale measured by the average gross production in the domestic firms to the estimated MES (minimum efficiency scales), FDI measured by the share of employees employed in foreign plants, average effective work days during 1970, and the degree of competition measured by different concentration indices such as the Herfindal index. The study found strong support for the existence of spillover benefits from FDI.

Blomstrom (1986) tested spillovers based on an efficiency index defined as the ratio of the average value added per employee in an industry and that of the best practice. He used data for 230 four digit Mexican manufacturing industries in 1970 and 1975. The independent variables included the Herfindahl index, market growth variables, defined as the relative growth of employment of each industry in the period 1970 to 1975, the rate of technological progress, defined as the changes in labour productivity in the best-practice plants within each industry, and foreign share, defined as the share of employees in foreign plants. He found a significant effect of the entry of foreign firms on the changes in each industry's average productivity. However, it had no impact on technical progress in the least productive firms in each sector. He interpreted these findings as indicating that foreign entries into Mexico did not speed up technology transfer, but that FDI promoted efficiency by increasing competition. Blomstrom and Wolff (1989) extended their previous studies by analysing the difference between productivity growth in local and foreign firms in Mexican manufacturing industries from 1970 to 1975. They found faster productivity growth in sectors with higher levels of foreign ownership.

Cantwell (1989) found spillovers to be significant in industries where the technology gap between local and foreign firms was low. By analysing the responses of local firms to the entry and presence of U.S. multinationals in eight European countries from 1955 to 1975, he found the growth rate of output of local firms was catching up only in those industries or countries where local firms already possessed high technology levels. He therefore claimed that technology spillovers mainly took place in local firms which were initially strong, with the weaker local firms either being forced out of business, or confined to the limited segments of the market neglected by the MNCs.

Using data for Venezuela between 1976 and 1989, Aitken and Harrison (1991) concluded that there was no general evidence of spillovers. However, they found that domestic firms located close to foreign firms tended to exhibit a higher growth rate of TFP, particularly in sectors such as food products, textiles, and basic metal, where levels of technology levels were relatively low.

Existing empirical studies differ in their estimates of the overall size and significance of spillovers. Most studies suggest that a spillover effect is created by foreign presence. However, some studies concluded no productivity growth can be attributed to FDI, or that FDI may even have a negative effect on domestic firms' output growth. Aitken and Harrison (1994) estimated the production function by a panel of Venezuela plants for the years 1976 through 1989. Their finding indicated the negative effect from FDI on domestic firms' output growth was overwhelming. They suggested less emphasis should be placed on the spillover effect.

Given the differences in conclusions about FDI and spillover effect, it is not surprising that more recent studies attempt to test the differences in spillovers among industries, usually by separating the sample into 'high' and 'low' technology groups and re-estimating the equation. Haddad and Harrison (1991) investigated the relationship between productivity growth and FDI in 4,236 firms in 18 two digit Moroccan industries from 1985 to 1989. Using the share of foreign assets in total assets at the sector level to proxy FDI, they found that the influence of FDI in reducing the dispersion of productivity was greater in the low technology sectors.[1]

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[1] They defined the high technology sectors to include machinery, transport, equipment, electronics, scientific instruments, and chemicals.

They interpreted this as indicating that competition due to FDI was more important in pushing firms toward the best practice frontier than the transfer of technology. Furthermore, spillovers occurred only when the productivity gap between domestic and foreign firms was not too large.

Kokko (1994) argues that the different findings from earlier studies suggest that host country characteristics may influence the incidence of spillovers. Kokko (1994) conducted a test using the information for 230 four digit Mexican manufacturing industries in 1970. He demonstrated that spillovers are related to various proxies for the complexity of MNC technology and the technology gap between locally-owned firms and MNC affiliates. The foreign presence, measured by the ratio of foreign plants' employment to total employment in each industry, entered the equation along with other variables, including the capital labour ratio, the ratio of white-collar to blue-collar workers measuring labour quality, and the Herfindahl index, which was used to measure the concentration of each industry. Value added per worker was the dependent variable. He divided the sample into groups with lower and higher technology gaps using three proxies. The first was the average patent fees per employee in each industry, the second the average capital intensity of the foreign affiliate, and the third was the labour productivity gap between local and foreign firms.

The result showed the existence of spillover effects in both groups. However, when the cross item between FDI and the technology gap was added in the model, the spillover in the group with the higher technology gap became insignificant. He concluded that this implies spillovers do not generally occur in industries with the most complex technologies. A large productivity gap and a large foreign market share together appears to create significant obstacles for spillovers because this allows the foreign affiliate to crowd out local competitors from the market. Based on the analysis, Kokko suggested that efforts to promote FDI by a host government should focus on industries where the local technological capacity is already relatively strong.

Kokko, Tansini, and Zejan (1996) later conducted a similar test using data for 159 Uruguay firms from 1988 to 1990. Spillovers were found to be insignificant. However, different results were found when the sample was divided into two groups, according to the technology gap.[2] The coefficient of FDI was positive and highly significant in the sub-sample with a small technology gap, but not significantly different from zero where the technology gap was large. This also suggested strong indications of in local plants with small technology gaps, but not in local plants far behind or ahead of the foreign affiliate in their technology levels.

Tsou and Liu (1994) analysed the relationship between labour productivity, technical efficiency, and spillover effect, using data from the Taiwanese industrial and commercial census in 1986 and 1991. They also divided the sample into a group with a lower technology gap between FDI and local firms, and a group with a higher technology gap between FDI and local firms, according to the average value of the ratio between value added per employee in local and foreign firms. The results showed a significant spillover effect in 1986 in the low technology group. In contrast, there was an insignificant relationship in the high technology industries. In 1991, the positive relationship in the low technology industry was not significant, and still negative and significant in the high technology industries in 1991. These results confirmed that domestic firms can only benefit from spillover effects when their technological capability is not greatly lower than that of the foreign counterpart. Therefore, a basic condition for domestic firms to benefit from spillover is to improve their technology capability.

Blomstrom, Kokko, and Zejan (1994) also conducted some explicit studies to test the determinants of technology transfer. They analysed how the technology imports of foreign firms are related to various industry characteristics. The hypotheses, following Wang and Blomstrom's model, was that market rivalry and the availability of skilled labour may encourage the MNC to bring more technology to their foreign operations. Their data was for Mexican manufacturing firms from 1970 to 1975, at the plant level, and aggregated into 230 four digit manufacturing industries in 1970 and 235 industries in 1975. They used data on foreign firms' technology payments abroad to construct a proxy for total technology imports, which makes up the dependent variable. The share of white-collar employees in the labour force or the wage payments by foreign firms approximated the availability of skilled labour. The

[2]The technology gap is defined as the ratio of average labour productivity of foreign firms to local firms in four digit industrial level.

growth rate of domestic firms in the total capital stock and their market share served as proxies for local competition. Data on the domestic firms' technology payments, the average license payments in U.S. industries, and the advertising expenditures of Mexican industries were used to control the variation that stems from basic technology differences. There was a significant relationship between the technology import of foreign affiliates and the local competitors' investment and output growth, and labour skills. The estimation results thus provided strong support for their hypotheses regarding the foreign firms' technology imports.

Using data from the manufacturing operations of the U.S. MNCs in 33 host countries in 1982, Kokko and Blomstrom (1995) conducted a similar test to examine how the technology imports of the U.S. majority-owned foreign affiliates were related to proxies for the host countries requirement for technology transfer, level of competition, and learning capacities. The dependent variable is the affiliates technology imports from all sources including transfers between parent and affiliates. The independent variables included the share of affiliates that faced various quantitative performance requirements. The local competition is proxied by gross fixed capital formation per employee and the gross fixed capital formation to gross output ratio. The results showed that the technology inputs of MNC affiliates increased with the competitive pressure of the host country. However, the payments of royalties and license fees were negatively related to performance requirements. Thus they found some support for the hypothesis proposed by Wang and Blomstrom (1992).

3.2.2 Problems with Previous Empirical Studies

Some studies have argued that the link between FDI and productivity might arise from the fact that MNCs pursue higher labour productivity and capital formation in the first place. This raises the question of whether FDI happens prior to higher labour productivity and capital formation. The major problem with previous attempts to measure spillover effects from foreign investment is that they did not take into account the causality between FDI and growth. Although this problem has been recognised by various studies, very few address it directly rather than accepting the convention that the direction of causality is from other variables, include FDI, to growth. The specification of the relationship in almost all previous estimations has been to regress labour productivity on FDI, which implicitly assumed that FDI is causally prior to, or at least independent of, economic growth. But causation can run both ways. The inflow of foreign investment could potentially react to the vitality of the domestic economy. Bell and Pavitt (1993) observed that 'in developing countries, foreign direct investment has generally been a consequence, rather than a cause of rapid industrialisation'.

Empirical evidence shows that firms increase investment in response to sales which rise with rising GDP. Bandera and White (1968) found a statistically significant correlation between the U.S. FDI to the European Union (EU) and these countries' incomes (GNP), and concluded that a motive to invest abroad can be summarised as a desire to penetrate a growing market defined in terms of the level and growth of GNP in host countries. In a large sample of developing economies, Renber et al. (1973) found that the flow of FDI into LDCs was correlated with their GDP. In spite of their differences with regard to assumptions, data, and specification of the variables, these studies come out in support of the proposition that FDI is positively dependent on output growth. Thus, it is possible that these studies may point either to a two-way process, with growth being fostered by FDI, itself induced by economic growth, or even a one way process from growth to FDI. As a result, one could find positive spillovers from foreign investment where no spillover occurs. Most empirical studies on FDI and spillover effects have employed the single equation approach, but because of the simultaneity problem, this approach may not generate credible estimates which are useful in policy analysis.

Kholdy (1995) employs the technique of Granger-Causality to investigate the direction of causation between FDI and spillover efficiency in some developing countries (Mexico, Brazil, Chile, Singapore, and Zambia) for the period 1970 to 1990. His findings do not support the efficiency spillover hypothesis, but rather, FDI is attributed to countries with higher factor endowments, an internal market, and more advanced technology in domestic production. The evidence on the direction of causality between FDI and growth highlights the importance of growth as a crucial determinant of FDI inflow.

Another problem with most of these studies is that they apply labour productivity as a proxy for technology. These analyses tested the existence of spillovers by measuring the effect of foreign presence, generally expressed in terms of the share of employment in the foreign firms in each industry's total employment, on labour productivity in local firms. Although labour productivity provides one measure of technological advantage, it is a partial measure that varies with capital intensity as well as the level of other factor inputs.

A third problem is that by ignoring causality, many studies failed to include some important factors in the productivity equation. Most of the studies emphasised the importance of factor input and labour quality. However, factors such as R&D and trade intensity are often not considered. The results from models which miss important variables are at best incomplete, and at worst misleading.

Finally, most of the earlier empirical studies did not provide a careful analysis on the underlying cause for the potential negative or positive impact of FDI on domestic firms' production. Given the complexity of this issue, the impact of the spillover effect from FDI remains an issue requiring further empirical studies.

3.3 FDI Studies in China

FDI inflow in China has attracted a great deal of attention in the academic field. These studies can broadly be classified into three categories. The first category examines the pattern of FDI in China, including a quantitative description of FDI inflow, assessment of the investment environment, and changes in China's economic policies. The second category examines the determinants of FDI in China. The third category assesses the impact of FDI on the industrial development and modernisation in China.

3.3.1 Studies on the Patterns of FDI in China

Much has been written about China's overall achievement in attracting foreign investment in China. A large number of documents have been devoted to a general profile of FDI in China. Among these studies, Kamath (1990, 1994) and Pomfret (1991, 1994) reviewed the experience of China's open door policy and discussed some of the lessons to be drawn from China's experience with FDI. Zhang and Tracy (1994) looked at the size, rates of growth, location, and main features of FDI and addressed the question of whether the large inflow of FDI will continue. Eng and Lin (1996) investigated foreign investors' penetration of the Chinese economy and their effort to build a competitive edge for operations in local and international markets. Fukasaku, Wall, and Wu (1994) provided a chronology of the evaluation of China's foreign investment policy. Chi and Kao (1994) analysed the general location and industrial distribution, source, and types of FDI in China by examining data from a sample of all foreign enterprises registered in 1991 over a period of 5 years. Wei (1995) investigated whether China has reached its potential in attracting FDI. Freeman (1994) gave a qualitative sectoral and regional profile of FDI in China and Vietnam.

Efforts have also been made to assess China's legal and policy framework with regard to FDI. Wu (1986) presented a critical overview of China's policy on FDI since its inception. He analysed the ideological change and assessed the legal-institutional framework of FDI in China. Kwon (1989) analysed the taxation framework for FDI in China. Huang (1995) offered a careful study of FDI inflows and related policies. Hayter and Han (1998) discussed the economic dilemma posed by FDI in the formation of policies. They evaluate the 'open policy' as a geopolitical strategy of the government designed to enhance technological and industrial capability by seeking know-how from MNCs. Zhang (1994) argued that developing country governments can not only activate existing, but also create new location specific advantages by analysing the performance of FDI in China, especially Guangdong province. Potter (1995) reviewed the structure and performance of foreign investment law and policies. He pointed out that, despite the fact that the Chinese legal regime for FDI has evolved significantly since its inception in 1978, in terms of basic laws of contract, taxation, foreign exchange, and other matters, problems such as inconsistent regulations still prevail.

3.3.2 Studies on the Determinants of FDI

Compared with the large numbers of studies on the patterns of FDI in China, much less research has been carried out to test the determinants of FDI. Wang and Swain

(1995) investigated the determinants of FDI in China from 1978 to 1982. The independent variables in their model included the size of the domestic market measured by GDP, the growth rate of GDP, wage rates, and imports. Using a single equation linear model, their study confirmed the positive effect of market size variable on FDI inflow. The wage rate was negatively related to FDI, and a negative coefficient was found between imports and FDI. This study is one of the few which applies econometric techniques. However, it was criticised by Matyas and Korosi (1996) for inconsistencies in numerical results and a lack of degree of freedom. The degree of freedom is only 3, given that the model estimates 12 unknown coefficients from 15 observations.

To increase the number of degree of freedom, Liu et al. (1997) used an error-components model to analyse the determinants of FDI in China based on data on FDI inflow from 22 countries/regions from 1983 to 1994. The factors tested included market size measured by GDP and wage rates. Their study showed a positive relationship between the market size variable and FDI inflow, and a negative relationship between the wage rate and FDI inflow.

Broadman and Sun (1997) focused on the geographical and sectoral distribution of FDI within China and develop an econometric model of its locational determinants. These determinants include market size proxied by regional GDP, labour cost, and human capital. The results showed that regional GDP is the most important factor in determining foreign investors' location choice in China. Adult literacy has a small, though significant, positive effect on the destination of FDI in China, while labour costs had no strong effect in determining the location of FDI within China.

Head and Ries (1995) developed a model in which tax incentives, infrastructure, labour costs, and self-reinforcing agglomeration economics, determine the location of FDI. The monopolistic-competition model developed predicts that the arrival of FDI in a city will stimulate entry by local suppliers, creating upstream growth which, in turn, makes the city more attractive to foreign investors. The hypothesis is supported by the estimation results using data on 931 investments in 54 cities from 1984 to 1991.

3.3.3 FDI, Technology Transfer, and Growth

The overall economic outcome of FDI inflow has been documented by many authors. It is a common belief that FDI is beneficial to China's economic development. For example, Lardy (1996) analysed how important foreign capital has been to China's growth acceleration in the reform period and identified those institutions and policies that have been most effective in this process. He concluded that FDI has contributed to China's rapid export growth. Kueh (1992), considered the impact of FDI on the coastal provinces, and concluded it had contributed to capital formation, output and income generation, and export growth. Hiemenz (1989) discussed the overall impact of FDI on economic development, regional growth, and trade. He suggested that the better economic performance of China in the 1980s was achieved by more efficient use of resources than by an increasing investment fund.

Chen, Chang, and Zhang (1995) critically assessed the role of FDI in China's economic development since 1978 in terms of GDP and domestic savings, fixed asset investment, foreign trade, and the transition to a market economy. They concluded that FDI had contributed to China's post-1978 economic growth by augmenting the resources available for capital formation and the contributions to China's export earnings.

In an attempt to analyse the relationship between FDI and growth in China, Shan et. al. (1997) tested the FDI-led growth hypothesis on China using the Granger-no-causality testing procedure. They constructed a Vector Autoregression (VAR) model on the basis of quarterly time series data over the period 1985 to 1996. The result indicates that there is a two-way causality running between FDI and growth in China.

Ideas differ in assessing FDI's contribution to technology transfer in China. Huang (1995) stated that FDI introduced advanced technologies into China. Lan and Yong (1996) studied technology transfer and adaptation in the Northeast city of Dalian based on interviews with 36 firms and concluded that FDI had transferred advanced technology to China. However, many others argued that relatively little advanced technology had been transferred. Given the preponderance of real estate, commercial, tourism-related FDI, and FDI in labour intensive manufacturing industries, the major transfer has been low level technology in areas classified by the government as 'non-productive' (Kamath 1990).

Despite the large number of studies, the relationship between FDI and technological spillovers in China is far from clearly defined. Due to the difficulties in obtaining data and the complexities in defining the relationships, work based on in-depth modelling on the effect of technological spillover and growth in China is scarce. Most studies are based on intuitive reasoning and are descriptive in nature. These descriptive studies help to shed light on the relationship between FDI and spillover effect in China, but a more systematic empirical study is needed.

There is also a lack of comparative studies between firms in different ownership categories and industries in China. One exception is Pan and Parker (1997), who have compared management attitudes in three kinds of firms in China. However, the study is based upon 16 enterprises in Shanghai and Nanjing.[3] Therefore, the applicability of the conclusions in their study may be limited by the small sample size.

3.4 Conclusions

In recent times, a major role in technology diffusion has been played by international corporations. The recognition of this important role during the past two decades has stimulated intensive debate on the role of FDI in growth. However, at present, a comprehensive theoretical model on FDI and the spillover effect is still lacking. Most of the existing models focus on technology transfer from a parent company to its subsidiary, while spillovers from a subsidiary to domestic firms have been assumed to be an automatic process. The unrealistic assumption about spillover and technology gaps has also been incorporated in all the existing theoretical studies. In the literature of growth theory, FDI has largely been ignored.

At the empirical level, much has been learned about spillovers from the large amount of research over the last two decades. However, many of the studies suffer from the problem of omitted variables, and do not provide careful analysis on the underlying causes for the potential negative or positive impact of FDI on domestic firms' production. The vast majority of studies employ a single equation OLS model to regress labour productivity on FDI. The possible two-way causality between FDI and

[3] Of the 16 firm, 3 were joint ventures, 2 were collectively-owned firms, and 11 are SOEs.

productivity growth is ignored. More work is needed to understand the process of technology spillovers from FDI, in particular, to help evaluate the mechanism of spillovers.

While the literature on FDI in China has grown rapidly, most is of a descriptive or polemical nature, and analytical formulations of FDI activities in China are quite scarce. Because of methodological difficulties, as well as the lack of data, little careful empirical investigation has been done to analyse FDI and spillovers in China. Most of the policy and empirical writings rely on intuitive reasoning. To provide a detailed and systematic study of FDI and spillovers in China, it is necessary to take a wide-angle view of the relevant economic activities of major players in the economic game. The assessment should have a framework that combines theoretical analysis, empirical analysis, and detailed case studies. Yet such a view is largely absent from the existing literature on the relationship between FDI and growth in China. The current study attempts to fulfil this task.

Chapter 4

Foreign Direct Investment and Domestic Firms' Productivity Growth: A Theoretical Analysis

As described in the previous chapter, a number of theoretical studies have analysed the relationship between foreign direct investment (FDI), technology transfer, and growth. One of the common features of these analyses is their focus on technology transfer from the MNC to its overseas subsidiary. The technology spillover from MNC subsidiaries to domestic firms is assumed to be automatic. Based on this assumption, the common conclusion that arises from these models is that technology spillover to domestic firms will increase with the increase of FDI inflow. In these models, domestic firms will always benefit from technology spillover induced by FDI inflow. Another common assumption of all these theoretical studies is that the rate of technological progress in a 'backward' region is an increasing function of the technology gap between it and the 'advanced' region. Therefore, technology spillover will be proportional to the technology gap between foreign firms and domestic firms.

Although these theoretical models show positive links between FDI and domestic firms' productivity growth, case studies and empirical research do not offer unambiguous support for the spillover hypothesis. The mixed results from empirical work calls for adequate theoretical analysis of the issue.

This chapter explores ways in which FDI influences the TFP growth of domestic firms. Underlying the study is the recognition that technology transfer from a parent company to a MNC subsidiary is not equivalent to technology spill over from the subsidiary to domestic firms. This study departs from most previous studies in three aspects. First, its focus is on how FDI is related to the TFP growth of domestic firms, given that technology transfers from a MNC to its subsidiary. In this sense, this paper is complementary to the analyses of Koizumi and Kopecky (1977), Findlay (1978), and Wang and Blomstrom (1992), by focusing on the relationship between domestic firms and FDI. Second, contrary to most models which incorporate the hypothesis of Gerschenkron (1962), the analysis allows for the possibility that the technology gap forms an obstacle for technology spillover from foreign to domestic firms. And third, FDI affects domestic firms not only in terms of technology spillovers, but also because competition from FDI can change the production behaviour of domestic firms.

The work of Aitken and Harrison (1991) has also touched upon the issue of the relationship between FDI and domestic firms' production. What distinguishes the model used in the present study is that the focus is directly on the TFP growth of domestic firms, while (Aitken and Harrison 1991) explore the relationship between domestic firms' output and FDI. Furthermore, the model in this study intends to explore the determining factors which affect the nature of the impact of FDI.

4.1 The Reaction Curves of a Domestic and a Foreign Firm

The model considers an industry consisting of two firms, a domestic firm and a firm with foreign investment, which entertain Cournot-Nash conjectures regarding each other. The products of these two firms are imperfect substitutes for each other. The domestic firm's product is denoted by Y_d, and that of the foreign firm is denoted by Y_f.

Domestic households consume goods Y_d and Y_f. Preferences of the representative household are represented by a quadratic utility function of the following form.

$$(4.1) \quad U(Y_d, Y_f) = a_0 Y_d - (a_1/2)Y_d^2 + a_0 Y_f - (a_1/2)Y_f^2 - a_2 Y_d Y_f .$$
$$a_0, a_1, a_2 > 0, a_1 \geq a_2$$

Utility maximisation yields inverse demand functions for Y_d and Y_f of the linear form,

$$(4.2) \quad P_d = a_0 - a_1 Y_d - a_2 Y_f ,$$
$$(4.3) \quad P_f = a_0 - a_1 Y_f - a_2 Y_d .$$

where subscripts d and f denote the domestic and foreign firm respectively, and P and Y denote price and output.

It is assume that both the FDI firm and the domestic firm have a Cobb-Douglas production function. The two firms each seek to minimise their costs. The cost minimisation problem of the domestic firm is

$$Min\, C_d(w,r,Y_d) = wL_d + rK_d\ ,$$
$$s.t.\, Y_d = AL_d^{\alpha_d} K_d^{\beta_d}$$

where L is the labour input, K is the capital input, w and r are the prices of labour and capital, respectively.

Assuming constant returns to scale, and solving the problem, gives the cost function of the domestic firm

$$(4.4) \quad C_d(w,r,Y_d) = A_d^{-1} H_d w^{\alpha_d} r^{(1-\alpha_d)} Y_d,$$

where $H_d = a^{-\alpha_d}(1-a)^{\alpha_d - 1}$ is a constant for a given production function.

The marginal cost is therefore

$$(4.5) \quad MC_d = A_d^{-1} H_d w^{\alpha_d} r^{(1-\alpha_d)} = A_d^{-1} G_d.$$

Correspondingly, the cost minimisation problem for the foreign firm is

$$Min\, C_f(w,r,Y_f) = wL_f + rK_f\ .$$
$$s.t.\, Y_f = AL_f^{\alpha_f} K_f^{\beta_f}$$

Similarly, assuming constant returns to scale, the cost function of the foreign firm is therefore:

$$(4.6) \quad C_f(w,r,Y_f) = A_f^{-1} H_f w^{\alpha_f} r^{(1-\alpha_f)} Y_f,$$

where $\quad H_f = a^{-\alpha_f}(1-a)^{\alpha_f - 1}$

and the marginal cost for the foreign firm is

$$(4.7) \quad MC_f = A_f^{-1} H_f w^{\alpha_f} r^{(1-\alpha_f)} = A_f^{-1} G_f.$$

In deciding how to supply the domestic market, the domestic firm and the foreign firm behave in a profit maximising fashion. The domestic firm maximises profits subject to the demand function (4.2)

$$Max \Pi_d = Y_d P_d - C_d,$$
$$s.t. \quad P_d = a_0 - a_1 Y_d - a_2 Y_f$$

where Π_d denotes the profit of the domestic firm, and C_d denotes the cost of the domestic firm. The firm's profit-maximising output level, given the output of its competitor, is obtained by setting $\partial \Pi_d / \partial Y_d$ equal to zero. This gives:

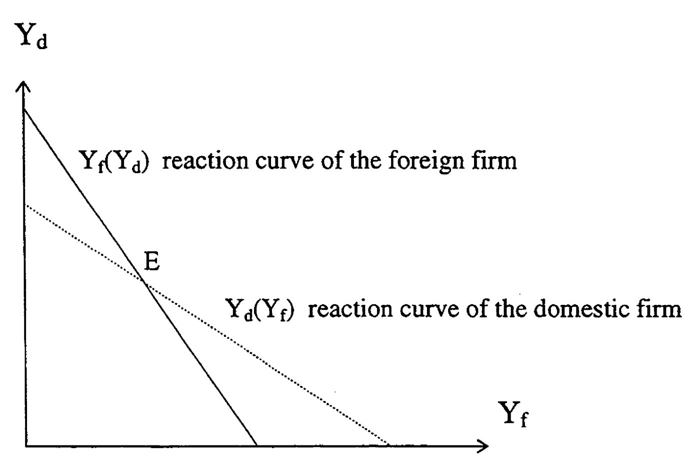
$$(4.8) \quad Y_d = (1/2a_1)(a_0 - a_2 Y_f - MC_d).$$

In a similar manner, the profit maximising output level for the foreign firm, given the output of the domestic firm, can be shown to be of the following form:

$$(4.9) \quad Y_f = (1/2a_1)(a_0 - a_2 Y_d - MC_f).$$

The outcome of this form of competition is the Cournot-Nash equilibrium. Equation (4.8) and (4.9) are often referred to as the reaction functions. They show the optimal level of output for each firm conditional upon the output level of its competitor. The reaction curve based on these reaction functions can be shown in Figure 4.1. The existence and stability of the Cournot-Nash equilibrium is discussed in Appendix 4.1.

Figure 4.1. Reaction curves between a domestic and a foreign firm



4.2 TFP Growth of the Domestic Firm When There Is an 'Adjustment Cost'

The forgoing analysis assumes that the domestic and the foreign firm both engage in cost minimisation and profit maximisation in a parallel manner. However, while it could be assumed that FDI firms in China operated basically according to market forces, domestic firms possess some special characteristics. After two decades of reform, state owned firms in China are still troubled by problems related to property rights, soft budget constraints, and heavy social obligations (see Chapter 6). While private firms and collectively owned firms in the non-state sector have more operational flexibility, they face more institutional constraints such as obstacles in terms of entry to markets and access to resources.

Modelling the behaviour of Chinese firms have been widely discussed (e.g. Wang, 1990a). This study adopts a simple framework to capture the relevant behaviour by assuming that the domestic firm in the model faces a fixed cost. In reality, there is no doubt that Chinese firms have other non-profit maximising behaviour and constraints. However, these behaviours only serve to reinforce the uncompetitive behaviour of Chinese firms in comparison with FDI firms. Following the analysis of Eriksson (1984, p:53), this fixed cost is named as 'adjustment cost'. Therefore, the cost function of the domestic firm becomes:

$$(4.10)\quad C_d(w,r,Y_d,C_{fd}) = A_d^{-1}H_d w^{\alpha d} r^{1-\alpha d} Y_d - C_{fd},$$

where C_{fd} is the adjustment cost. Equation (4.10) can be rearranged into the following form:

$$(4.11)\quad C_d(w,r,Y_d,F) = A_d^{-1}\, H_d w^{\alpha d} r^{1-\alpha d} (Y_d - F_d),$$

where $$F_d = C_{fd} / (A_d^{-1}\, H_d w^{\alpha d} r^{1-\alpha d}).$$

Duality implies that the domestic firm has a production of the following form:[1]

$$(4.12)\quad Y_d = A_d L_d^{\alpha d} K_d^{\beta d} - F_d .$$

Manipulating the domestic firm's production function in a similar manner as in the analysis of Aitken and Harrison (1994), gives,

$$\begin{aligned}(4.13)\quad Y_d &= A_d L_d^{\alpha d} K_d^{\beta d} - F_d \\ &= A_d L_d^{\alpha d} K_d^{\beta d} (1 - F_d / (A_d L_d^{\alpha d} K_d^{\beta d})) \\ &= A_d L_d^{\alpha d} K_d^{\beta d} ((A_d L_d^{\alpha d} K_d^{\beta d} - F_d) / (A_d L_d^{\alpha d} K_d^{\beta d})) \\ &= A_d L_d^{\alpha d} K_d^{\beta d} (Y_d / (Y_d + F_d)) \\ &= A_d L_d^{\alpha d} K_d^{\beta d} ((Y_d + F_d) / Y_d)^{-1} \\ &= A_d L_d^{\alpha d} K_d^{\beta d} ((1 + F_d / Y_d)^{-1} .\end{aligned}$$

The logarithmic form of this production function is:

$$(4.14)\quad LogY_d = LogA_d + \alpha_d LogL_d + \beta_d LogK_d - Log(1 + (F_d / Y_d)),$$

when $F_d < Y_d$, $Log(1 + (F_d / Y_d)) = F_d / Y_d$.[2] Thus, the production becomes

$$(4.15)\quad LogY_d = LogA_d + \alpha_d LogL_d + \beta_d LogK_d - F_d / Y_d .$$

Subtracting each variable of time *t* by the corresponding variable in time *(t-1),* and following the definition of the Divisia index of TFP growth, TFP growth from this production function is:

$$(4.16)\quad TFPG_d = \Delta LogA_d - F_d (1 / (Y_{d(t)} - 1 / Y_{d(t-1)})).$$

---

[1] Given the cost function, the input requirement of a technology can be obtained according to the derivative property. That is

$$L = \partial C / \partial w, \qquad K = \partial C / \partial r$$

Where *C* is the cost function, *L* and *K* denote labour and capital input respectively, and *w* and *r* are the price of labour and capital. The corresponding production function can be obtained by manipulating these relationships.

[2] When

$X < 1, e^x = (1 + X / 1! + X / 2! + ... + X / n!) = (1 + X)$. Therefore, $X = Log(1 + X)$.

where $TFPG_d$ refers to the domestic firm's TFP growth, Δ refers to change of the variable from time *(t-1)* to time *t*, $Y_{d(t)}$ and $Y_{d(t-1)}$ denote output of the domestic firm in time *t* and *(t-1)* respectively.

In deciding how technology leaks from the foreign firm to the domestic firm, the assumption of Wang and Blomstrom (1992) is adopted, which states that technology transfer through FDI is positively related to the level of the foreign firm's production and the domestic firm's learning investment. To be more specific, the foreign firm's production is related to the change of the domestic firm's productivity level A_d in the following form

$$(4.17)\quad \Delta \dot{A}_d = e^{(qY_f * I_d)},$$

where I_d represents the domestic firm's incentive, and effort to engage in active learning from FDI, q is a positive constant. For simplicity, assume $q = 1$.

Substituting (4.17) into the TFP growth equation (4.16), the TFP growth expression becomes:

$$(4.18)\quad TFPG_d = Y_f I_d - F_d(1/Y_{d(t)} - 1/Y_{d(t-1)}).$$

Further substituting the domestic firm's reaction function (4.8) into (4.18), the TFP growth expression of the domestic firm becomes:

$$\begin{aligned}(4.19)\quad TFPG_d &= Y_f I_d \\ &- \{2a_1 a_2 F_d (Y_{f(t)} - Y_{f(t-1)}) \\ &/ [(a_0 - a_2 Y_{ft} - MC_d) / (a_0 - a_2 Y_{f(t-1)} - MC_d)]\}.\end{aligned}$$

where $Y_{f(t)}$ and $Y_{f(t-1)}$ are the output of the foreign firm at time *t* and *(t-1)* respectively.

The effect of changes of the foreign firm's output Y_f on TFP growth of the domestic firm can be examined by differentiating the domestic firm's TFP growth with respect to Y_f, that is,

$$(4.20)\quad \partial\, TFPG_d / \partial Y_f = I_d - [2a_1 a_2 F_d / (a_0 - a_2 Y_{f(t)} - MC_d)^2].$$

Since a_0, a_1, and a_2 are positive constants, $\partial\, TFPG_d \,/\, \partial Y_f$ can take any value. It is obvious that the condition for $\partial\, TFPG_d \,/\, \partial Y_f < 0$ is to have low I_d and large F. The result associated with the above exercise can be summarised as follows:

Result 4.1: There exists a critical value $F_d > (I_d(a_0 a_2 Y_{f(t)} - MC_d)^2)/2a_1 a_2$ *such that* $\partial\, TFPG_d \,/\, \partial Y_f < 0$.

This result suggests that when the domestic firm faces an adjustment cost and has a low incentive to learn, the expansion of the foreign firm's production may cause the domestic firm's TFP growth to decrease.

4.3 The Effect of the Technology Gap on the Relationship between FDI and the Domestic Firm's TFP Growth

It is widely recognised that the existence of firm specific assets is one of the major factor behind the establishment of MNCs (Cantwell and Dunning 1991). The most important firm specific asset is the firm's possession of private production knowledge created through R&D. The foreign firm in the current model is assumed to possess such technological superiority.

It is possible for technology to spillover from the foreign firm to the domestic firm. Studies show that one important factor determining technology spillover is the size of the technology gap between the foreign and domestic firm. There are basically two hypotheses regarding the relationship between spillovers and the technology gap. On the one hand, the hypothesis of Gerschenkron (1962) states that the greater the relative disparity in development levels between a backward country and the industrialised countries, the faster the rate at which the backward country can catch up. On the other hand, numerous studies have shown that a large technology gap actually forms an obstacle for technology spillover (Cheng 1984).

Based on results from some earlier studies and firm interviews of this study (see Chapter 8), the hypothesis this study adopts is that technology spillover is negatively related to the technology gap between the domestic and foreign firm. This leads to the specification of the following relationship between the domestic firm's productivity change and the foreign firm's output,

$$(4.21)\quad \Delta A_d = e^{(Y_f * I_d / s)},$$

where S denotes the technology gap between the domestic and foreign firm.

When there is a technology gap between the domestic and the foreign firm, the relationship between the domestic firm's TFP growth and the foreign firm's output change can be analysed in the following two cases.

4.3.1 When the Domestic Firm Does Not Face an Adjustment Cost

When there is no adjustment cost, the TFP growth expression in equation (4.16) is reduced to:

$$(4.22)\quad TFPG_d = Log(\Delta A_d) = (Y_f I_d / S), \qquad \text{and}$$

$$(4.23)\quad \partial TFP_d / \partial Y_f = I_d / S.$$

When I_d is given,

$$\partial TFP_d / \partial Y_f \rightarrow 0,$$
$$\text{when} \quad S \rightarrow \infty.$$

It follows naturally from the assumption that the technology gap is negatively related to the domestic firm's ability to learn. This leads to result 4.2.

Result 4.2: When the domestic firm does not face an adjustment cost, with the increase of the technology gap between the foreign and the domestic firm, the domestic firm's TFP growth ceases to increase when the foreign firm's output increases.

The result implies that with the increase of the technology gap between the domestic and the foreign firm, the domestic firm faces increased difficulty in extracting benefits from the spillover effect. However, since there is no adjustment cost, the domestic firm's TFP growth does not decrease with the increase of the foreign firm's output.

4.3.2 When the Domestic Firm Faces an Adjustment Cost

In this case, the relationship between the foreign firm's output and the domestic firm's TFP growth is expressed as:

$$(4.24)\quad \begin{aligned} TFPG_d &= (Y_f I_d / S) \\ &\quad - \{2a_1 a_2 F_d (Y_{f(t)} - Y_{f(t-1)}) \\ &\quad / [(a_0 - a_2 Y_{ft} - MC_d) / (a_0 - a_2 Y_{f(t-1)} - MC_d)]\}, \end{aligned}$$

and

$$(4.25)\quad \partial\, TFPG_d / \partial Y_f = I_d / S - [2a_1 a_2 F_d / (a_0 - a_2 Y_{f(t)} - MC_d)^2].$$

The condition for $\partial\, TFPG_d / \partial Y_f < 0$ is that

$$(4.26)\quad F_d > (I_d (a_0 - a_2 Y_f - MC_d)^2) / 2a_1 a_2 S.$$

This leads to:

Result 4.3: When the domestic firm face an adjustment cost and when there is a technology gap between the domestic and the foreign firm, there exists a critical value $F_d > (I_d (a_0 - a_2 Y_f - MC_d)^2) / 2a_1 a_2 S$ *such that* $\partial\, TFPG_d / \partial Y_f < 0$.

This result indicates that when a domestic firm faces a high adjustment cost, makes a low learning effort, and lags behind a foreign firm in technology, then the TFP growth of the domestic firm decreases when the foreign firm's output increases.

4.4 The Mechanism by Which the Foreign Firm Influences the TFP Growth of the Domestic Firm

The reaction function (4.8) demonstrates how the domestic firm responds to the foreign firm's output increase.

In equation (4.8), substituting the expression for MC_d with the relationship between the domestic firm's productivity change and Y_f, the equation becomes

$$(4.27)\quad Y_d = (1/2a_1)(a_0 - a_2Y_f - G_d e^{-(Y_f I_d)/s}).$$

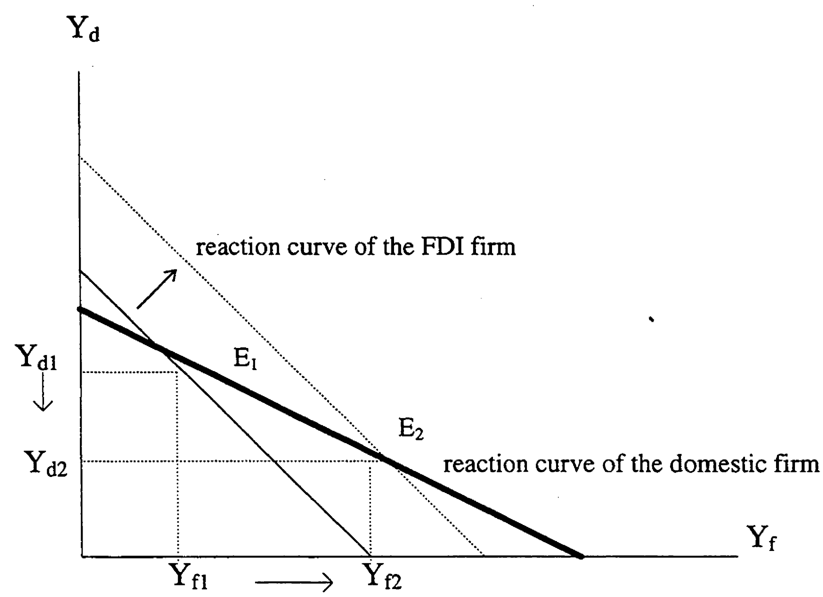
Therefore,

$$(4.28)\quad \partial Y_d / \partial Y_f = ((I_d G_d e^{-(Y_f * I_d / S)} / S) - a_2) / 2a_1.$$

The expression can take any value, and $\partial Y_d / \partial Y_f < 0$ when $(I_d e^{-(Y_f I_d / s)} / S) < (a_2 / G_d)$.

Hence, when the domestic firm's effort to learn is low and when the technology gap between the domestic and the foreign firm is high, the domestic firm cannot maintain its market share. The expansion of the FDI firm's production will therefore squeeze the domestic firm's output. This can also be shown by the following figure:

Figure 4.2. Reaction curves with an increased in the foreign firm's output



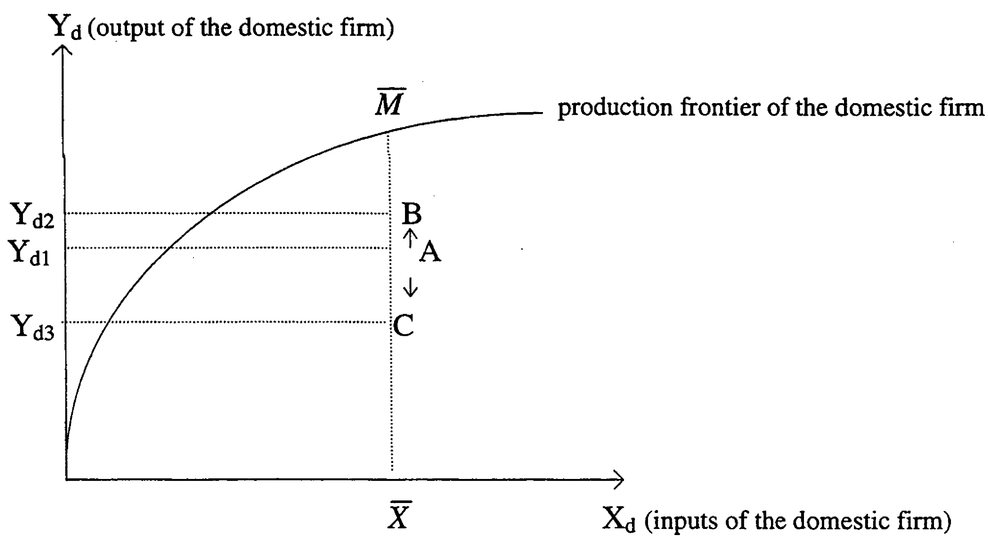
With the reduced output, the change of TFP growth depends on whether the domestic firm faces an adjustment cost. It can be shown following equation (4.16), that

$$(4.29)\quad \partial TFPG_d / \partial Y_d = F_d / Y_d^2.$$

When there is no adjustment cost, i.e. $F_d = 0$, then $\partial TFPG_d / \partial Y_d = 0$. This means that with the decreased output level, the domestic firm can maintain the TFP growth level by adjusting its inputs level.

When there is an adjustment cost, i.e. $F_d > 0$, then $\partial TFPG_d / \partial Y_d > 0$. In this case, a reduced output level of the domestic firm leads to reduced TFP growth. The reason is that with a high adjustment cost, the domestic firm faces difficulties in adjusting its level of inputs level to maintain the TFP growth level. Therefore, when the output level decreases and inputs levels can not be adjusted to match the extent of output change, TFP growth of the domestic firm falls. The reduction of the domestic firm's TFP growth is realised by forcing the domestic firm's output below the production capacity, which is represented by the production frontier (Figure 4.3).[3]

Figure 4.3. The efficiency change of the domestic firm



The technological progress represented by the outward move of the production frontier is not considered in the above figure. The production of the domestic firm is initially at *A* where the domestic firm produces Y_{d1}. The increase of the domestic firms' output, induced by technology spillovers from FDI, can be represented by *B*, where the domestic firm produces Y_{d2}. An output reduction induced by competition

[3] Figure 4.3 shows the special case that the domestic firm does not adjust inputs level with the lowered output level. A similar outcome exists if the domestic firm's input adjustment is not sufficient enough to offset the efficiency decrease due to output reduction when it faces a high adjustment cost.

from the foreign firm's output expansion can be indicated as a downward move to C. Therefore, the net effect of the foreign firm's output expansion on the domestic firm's production is the difference of AC and AB. When AB is greater than AC, the domestic firm's TFP decreases with the increase of FDI. Initial technological inefficiency is represented by $\overline{M}A$ if the production of the domestic firm was assumed to be below capacity before expansion of the FDI firm's production. With output being forced to reduce further from the productive capacity, technical inefficiency increases. Since technological efficiency is an important part of TFP growth, this means the TFP growth is also reduced. This leads to result 4.4:

Result 4.4: Given that $\partial TFPG_d / \partial Y_d = F / Y_d^2$, when the domestic firm's output level decreases as the foreign firm's output expands, the domestic firm's TFP growth can either remain unchanged or decrease, depending on whether the domestic firm faces an adjustment cost.

Therefore, the effect of FDI on the domestic firm's TFP growth can be viewed as consisting of two components, a positive effect which results from technology leakage from a foreign firm to a domestic firm, and a negative effect related to output reduction of the domestic firm when the output of the foreign firm increases. Accordingly, two factors are considered important in determining which effect will dominate. The first is the domestic firm's incentive to learn from the foreign firm, which will further determine the effort the domestic firm will make to improve its technology level in order to catch up with the foreign firm. The second is the technology gap between the domestic firm and the foreign firm, which determines the ability of the domestic firm to gain from FDI. In this sense, contrary to the commonly held view, competition from a foreign firm need not always raise the productivity of domestic firms.

4.5 Conclusions

This chapter examines the effect of foreign firms' production on domestic firms' TFP growth by constructing a simple model for an industry consisting of two firms, one MNC subsidiary and one domestic firm. By taking into account the strategic interaction between these two firms, this study shows that FDI may reduce domestic firms' TFP growth.

What is shown in the model, is that FDI affects domestic firms' TFP growth through two factors. On the one hand, FDI can benefit domestic firm's TFP growth by bringing in advanced technology which may spill over to domestic firms. Domestic firms' TFP growth increases with the technology spillovers from FDI. On the other hand, domestic firms' TFP growth decreases when competition from foreign firms causes domestic firms to cut production. When a domestic firm faces an adjustment cost so that it is not able to adjust its input level sufficiently to maintain its TFP growth level, the domestic firm's TFP growth may decrease.

Two factors are proposed to determine the dominance of the negative or positive effect of FDI on a domestic firm's TFP growth. The first is the learning incentive of the domestic firms, interpreted as a strong incentive and effort to gain from technology spillover. Secondly the domestic firms' ability to learn, which, in turn, depends on the technology gap between domestic and foreign firms. Naturally, if domestic firms work harder and do not face great technological distance from foreign firms, it is likely that the domestic firm will benefit more from FDI.

The demonstrated relationship shows that attracting FDI inflow is not a sufficient condition for host country firms to benefit from spillover effects. To the extent that the entry of foreign firms is essential for the introduction and transmission of new ideas and new knowledge, it is also essential for domestic firms to be willing, and capable of, extracting the full gain of spillover effects. These findings suggest that for FDI to promote the growth of domestic industries, the recipient economy must make efforts and have attained a level of development that allows it to reap the benefits of the advanced technology fostered by FDI.

The model developed is capable of accommodating some aspects of the relationship between FDI and domestic firms' TFP growth. However, the analysis has been confined to a static partial equilibrium framework. The model has also assumed that technology transfer from the patent company to its subsidiary is exogenous. No direct welfare significance has been attributed to the results.

Appendix 4.1. The existence and stability of the Cournot-Nash equilibrium in Figure 4.1.

The existence of Cournot-Nash equilibrium

The existence of a Cournot-Nash equilibrium in Figure 4.1 means that the reaction curve of the domestic and the foreign firm intersect in the first quadrant. This situation is ensured when the following two conditions are satisfied.

First, the slope of the reaction curve of the domestic and the foreign firm are not equal to each other. It is clear from equation (4.8) that the slope for the domestic firm's reaction curve is

$$(4.A1)\quad \partial Y_d / \partial Y_f = -a_2 / 2a_1 .$$

Correspondingly, the slope for the foreign firm's reaction curve can be derived from equation (4.9).

$$(4.A2)\quad \partial Y_d / \partial Y_f = 1/(\partial Y_f / \partial Y_d) = -2a_1 / a_2 .$$

For the slope of the two reaction curves to be different, the following condition should exist:

$$(4.A3)\quad a_2 \neq 2a_1 .$$

The second condition for the existence of the Cournot-Nash equilibrium is that the two reaction curves intersect in the first quadrant. That is, in equilibrium E, both Y_f and Y_d are non-negative. Equation (4.9) indicates the domestic firm's output level Y_d at E is

$$(4.A4)\quad Y_d = (a_0 - MC_f - 2a_1 Y_f) / a_2 .$$

Equalising Y_d in equation (4.4A) to that in equation (4.8), leads to the following result:

$$(4.A5)\quad Y_f = [(a_2(a_0 - MC_d) - 2a_1(a_0 - MC_f)] / (a_2^2 - 4a_1^2) .$$

For $Y_f > 0$, the following relationship must hold:

(4.6A) $$\{[(a_2(a_0 - MC_d) - 2a_1(a_0 - MC_f)] / (a_2^2 - 4a_1^2)\} > 0.$$

The stability of the Cournot-Nash equilibrium

Equations (4.8) and (4.9) denote the following system

(4.8A) $$Z_d = Y_d - ((a_0 - a_2 Y_f - MC_d) / 2a_1) = 0,$$

(4.9A) $$Z_f = Y_f - ((a_0 - a_2 Y_d - MC_f) / 2a_1) = 0.$$

A sufficient condition for the system to be stable is that

$$\begin{vmatrix} \partial Z_d / \partial Y_d & \partial Z_d / \partial Y_f \\ \partial Z_f / \partial Y_d & \partial Z_f / \partial Y_f \end{vmatrix} > 0 \quad .$$

This means

$$\begin{vmatrix} 1 & (a_2 / (2a_1)) \\ (a_2 / 2a_1) & 1 \end{vmatrix} > 0.$$

The condition for this relationship to hold is that

(4.10A) $$a_2 < 2a_1.$$

Relating this to equations (4.A1) and (4.A2), it is clear that the condition in (4.10A) means that the reaction curve of the foreign firm in Figure (4.1) should be steeper than the reaction curve of the domestic firm.

Condition (4.10A) also indicates that for the relationship in equation (4.6A) to be satisfied, it must be that

(4.6A1) $$(a_2(a_0 - MC_d) - 2a_1(a_0 - MC_f) < 0, \qquad \text{or}$$

(4.6A2) $$(a_2 MC_d - 2a_1 MC_f) < a_0(a_2 - 2a_1).$$

Since $(a_2 - 2a_1) < 0$, and $a_0 > 0$, equation (4.6A2) implies that

$$(4.6A3) \qquad MC_d < 2a_1 MC_f / a_2, \text{ or } (MC_d / MC_f) < (2a_1 / a_2).$$

Therefore, the difference between the marginal costs of the domestic and the foreign firm is important in determining the existence of the equilibrium. When $2a_1$ is not greatly larger than a_2, the condition for relationship (4.6A3) to be satisfied is that the marginal cost of the domestic firm should not be much greater than that of the foreign firm. Therefore, if there is a large difference between the marginal cost of the domestic and the foreign firm, a stable Cournot-Nash equilibrium will not exist.

Chapter 5.

The Major Players on China's Industrial Stage: A Comparison of Their Productive Performance

The neoclassical growth models attribute output growth that is not accounted for by input growth to total factor productivity growth (TFP). Therefore, TFP growth represents an increase in the efficiency with which an economy uses its productive inputs. It is an important measure of overall productivity and competitiveness of firms, and constitutes a significant source for sustainable long term economic growth. In the words of Jorgenson and Griliches (1967, p. 250), TFP growth reflects 'the effect of costless advances in applied technology, managerial efficiency, and industrial organisation'.

The analysis of the relative performance of TFP growth between domestic firms and foreign firms is important for examining technological spillover effects. A higher rate of TFP growth of foreign firms is a necessary condition for this potential effect to take place. Even in the absence of spillover effects, the higher TFP growth of foreign firms will increase overall productivity of national industry because MNCs are a part of the national economy.

Since the initiation of China's economic reforms in the early 1980s, there has been a substantial amount of empirical work conducted on TFP growth in China. Despite the impressive number of studies, there is still an inadequate understanding of this issue. Most of the analysis has focused on the state sector, and is based on aggregated data for the entire manufacturing sector, or even the entire industrial sector.[1] Studies on the non-state sector and more disaggregated industry branches have been limited.

[1] The entire industrial sector includes manufacturing sector, mining, and utility sector.

An understanding of the trend of TFP growth in Chinese industry is critical for evaluating the likely effectiveness of economic reform. However, excessive reliance on aggregate data conceals considerable performance differences among enterprises in different industries and different ownership categories. Due to economic reform, the Chinese economy has been transformed from a solely state controlled economy into a more complex system with the coexistence of firms in various ownership categories.

The major sectors are the state sector, the collective sector, and the FDI sector. According to the official definition, the state sector refers to the sector in which the productive inputs and outputs belong to the whole people. The inputs and output of the collective sector belong to a group of people, such as people in a county or a village. The FDI sector refers to the sector with foreign direct investment[2] (China Statistical Yearbook, 1991, p. 448). In 1996, the corresponding output shares for the state sector, the collective sector, and the FDI sector were 44.70, 30.74, and 18.67 percent, respectively. A meaningful evaluation of productivity performance in Chinese industry requires an investigation of the performance of firms in these three ownership categories, and this chapter attempts to fulfil this task.

Unlike previous attempts, this study is comprehensive in its coverage by comparing TFP growth for firms in different industries. It evaluates the TFP growth of 28 Chinese manufacturing industries for the period 1993 to 1995. This study contributes to the existing literature in three aspects. First, it is the first attempt to study the TFP performances for all manufacturing branches in both the state and the collective sector since 1985. Second, it is the first attempt to study industry level TFP performance of the FDI sector, which is virtually absent in the current literature. Thirdly, it utilises the most recent data, while most available studies employ data from the 1980s or early 1990s.

This chapter is organised as follows. Section 5.1 reviews the growth accounting measurement of TFP growth; section 5.2 looks into previous studies on TFP growth in China; section 5.3 presents results from the TFP analysis, and section 5.4 offers conclusions.

[2] See Chapter 2 for the types of FDI in China.

5.1 Growth Accounting and Related Issues

Over the years, various approaches have been developed to measure TFP growth, including the growth accounting method, exact index numbers, non-parametric methods using linear programming, production function with a time trend, meta-production function, and frontier methods (Diewert 1981).

Of these, growth accounting has been the method most widely used for estimating TFP growth. The economic theory underlying growth accounting measurement is closely related to the theory of cost and production. In the growth accounting exercise, if $Y(t) = f(X_{1t}, X_{2t}, X_{3t}, ...t)$, TFP growth based on the Tornqvist index[3] is given by the following equation:

$$(5.1) \quad TFPG = (LnY_t - LnY_{(t-1)}) - \sum_i (1/2)(e_{it} + e_{it-1})(LnX_{it} - LnX_{it-1}),$$

where Y is the output, X_{it}s are the inputs, e_{it} is the input elasticity of input i, and t refers to time.

In the growth accounting literature, two methods are used to measure the output elasticity of each input. The first is the econometric estimation of the production function, in which the parameters are estimated statistically. The second is the non-econometric method which assigns output elasticity of inputs according to the cost share of each input by taking additional assumptions. The main assumptions are that output and factor markets are competitive, and that firms maximise profit subject to constant returns to scale. Under these conditions, the first order condition of profit maximisation leads to the equalisation of output elasticity for each input to the cost share of each input.

With the exception of producer equilibrium assumptions, there are no fundamental differences between the econometric and non-econometric approach. Each method has its own strengths and weaknesses. The advantage of the econometric approach lies in its ability to perform statistical tests with regard to the various assumptions

[3] The derivation of the Tornqvist index is given in section 5.3.

such as constant returns to scale, neutrality, and separability. However, this approach requires a reasonably large number of observations. The advantage of the non-econometric method lies in its simplicity and the possibility to estimate TFP growth even when data is limited. The main disadvantage is its inability to check the assumptions statistically. The production function used in the non-econometric method is usually a simple Cobb-Douglas production function with constant returns to scale. The use of factor shares as a substitute for elasticities assumes that capital and labour markets are perfectly competitive. It also assumes that the adjustment of output and input levels is instantaneous. These assumptions are questionable in most countries.

Measurement of TFP growth based on the growth accounting method has been widespread in research and policy analyses. However, development in the past decades has also shown its limitations. Being a residual term, the TFP growth estimate has been criticised for including all that is not accounted for, including qualitative improvement in capital and labour, economies of scale, and X-efficiency (Abramovitz 1986).

Problems also arise due to the existence of non-neutrality of technological progress, movement of elasticity of substitution, economies of scale, non-homogeneity of underlying production functions, and the embodiment of technology in inputs. These attributes are not independent of one another, nor do they remain constant over time (Nadiri 1972).

There are also difficulties with specific measurement of TFP growth by the growth accounting method. Several choices have to be made. One of these is whether to use gross output with capital, labour, and intermediate input as inputs or value added and capital and labour as inputs. The condition for using the value added framework is that capital and labour should be weakly separable from the intermediate inputs.[4] In practice, the separability condition is often taken as granted.

[4] Weakly separable means that marginal rate of substitution between pairs of factors in the separated group (capital and labour) are independent of the level of factors outside of the group (intermediate input).

TFP growth estimates are also sensitive to the weight of inputs. The variations of TFP estimates are often caused more by the difference in factor shares than factor growth itself. Since capital usually grows faster than labour, assigning a higher capital share results in lower TFP growth. The negative correlation between TFP growth and capital has been found to be strong (Sarel 1997). This suggests that estimating the production function to find the elasticities of output with respect to each factor is an improved method for obtaining factor shares compared with assigning factor shares without statistical tests.

TFP estimates are highly sensitive to the data used. The choice of data and the way data is measured, however, can be problematic. The variables most often measured with error are capital service and input price indexes. Capital service is an unobserved variable and must be obtained indirectly. One common way to infer the level is to proxy capital service by the capital stock data. This is based on the assumption that the level of capital service is proportionally related to the level of capital stock. The capital stock series is usually constructed by the perpetual inventory method which assumes that the stock of capital is the accumulation of past investment after depreciation. The mathematical representation of this method takes the form:

$$(5.2) \qquad K_t = (1-d)K_{(t-1)} + I_t ,$$

where K is capital stock, I is investment at a constant price, d is the rate of geometric decay, and subscript donates time. It is not easy to select the exact depreciation rate and price index of capital at an aggregated level. Theoretically, different depreciation rates should be assigned to capital of different vintage due to later capital being more productive, which means that higher depreciate rates for old capital stock are needed. However, a constant depreciation rate is often applied in practice. This leads to error in the measurement of capital input and the error accumulates over time.

Another bias can occur when an output price index is used to deflate value added. Value added is the difference between the value of gross output and the cost of intermediate inputs. A real value added deflator should incorporate movement in the prices of intermediate inputs as well as movement in the price of gross output. A simple method to do so is to deflate nominal output and nominal intermediate inputs with their respective price indices and then subtract the real value of intermediate inputs from the real value of gross output. However, it is a common practice to deflate value added with an output price index because of the lack of price index for the intermediate input. When the prices of output and intermediate inputs are not moving parallel to each other, the price index of gross output does not equal that of the value added, and bias occurs.

With the development of econometric techniques, methods have been developed to test and capture effects such as non-neutral technological progress, economies of scale, and embodiment of technology in production function estimates. However, completely overcoming the limitations requires data that are normally impossible to obtain.

Although it is worth noting that the measurement of TFP growth is sensitive to both the method of estimation and the information sources, the results from growth accounting have proven to be useful policy parameters. This approach is an analytical simplification that makes it possible to summarize detailed information about the complex process of economic growth within a simple framework (Hu and Kjan 1991). It provides a filing system that is complete in the balance sheet of the production framework. Until a commonly accepted better approach is developed, the TFP growth index calculated from the growth accounting method is still an useful indicator of performance.

5.2 TFP Studies of Chinese Industry - A Survey

The rapid growth of the Chinese economy has created great interest among economists and policy analysts. There is a growing literature on TFP growth in the Chinese industry.

TFP growth of the state sector has been the main research focus. The evidence is mixed. One group of economists has found significant productivity growth and concluded that economic reform has promoted growth. For example, Chen et al. (1988) estimated TFP growth by using reconstructed data on labour, fixed capital, and net output value for the period 1953-1985. They concluded that following stagnation during the 1957-78 period, TFP growth in state industry displayed a growth rate of 4 to 5 percent per annum during the period 1978 to 1985. Lau and Brada (1990) used the same data set as Chen et al (1988) to estimate a frontier production function. The rate of technological progress in their study was between 1.8 and 3.6 per cent per year. Dollar (1990) confirmed the findings of Chen et al (1988) at the firm level. The World Bank (1992) also concluded that there was positive growth at an annual rate of 2.4 percent during the period 1980 to 1988.

On the other hand, another group of economists found the long term pattern of TFP stagnation had not altered, and concluded that China's decades-long effort of economic reform has been unsuccessful in the industrial sector. The World Bank (1985) using hypothetical weights for aggregate capital and labour input, reports that TFP declined for the period of 1957 to 1982. Chow (1985) estimated factor weights from a Cobb-Douglas production function and assumed constant returns to scale. He concluded that TFP did not increase over the 1952 to 1981 sample period. Employing the stochastic frontier method, with data constructed from an enterprise survey for sixty seven SOEs in China's four coastal cities in 1992, Huang and Kalirajan (1996) conclude that, after nearly two decades' of reform, the average level of firm specific technical efficiency was still very low, averaging only 30 percent.

Recent discussions indicate that the use of a different price deflator for intermediate inputs in estimation might be one source for such contradictory evidence. Woo et al. (1994) suggested the results of Jefferson et al (1992) might come from over-deflation of intermediate inputs which leads to overstating TFP growth. They concluded that productivity growth in the state sector had been zero at best from 1984 to 1988. However, this finding was later questioned by Jefferson et al (1994) for their choice of deflators.

Most of the existing studies are based on aggregate data at the national level. However, some recent investigations are extended to include analysis of TFP growth in individual industry branches. McGuckin et al. (1992) provided the most thorough industrial level TFP evaluation by using data from 1985 industrial census[5] for large and medium enterprises for 28 manufacturing industries and 11 non-manufacturing industries during the 1980 to 1985 period. They found a positive trend in TFP growth from 1980 to 1984 and from 1984 to 1985 at the total industry level. This improvement came from manufacturing industries as non-manufacturing TFP declined in both periods. Their study suffered from some data problems in the sense that the cost shares of each input was used as its weights. Value added and intermediate inputs were deflated by the output deflator. And the capital stock deflator was constructed by an weighted output price index of five capital goods producing industries.

Using annual survey data for 769 SOEs for 1980-1989 in four provinces (Sichuan, Jiangsu, Jilin, and Shanxi), Groves et al. (1994) found TFP growth for firms in the sample rose at an annual rate of 4.5 percent between 1980 and 1989. However, considerable variation across industries underlies the aggregate growth. Huang et al (1998) used survey data for 681 SOEs from the same provinces to analyse TFP growth in six sectors, namely, food and beverage, textile, chemicals, building materials, machinery, and electronics, during 1980 to 1994. The results show that TFP growth in most industries either stagnated or declined, with the exception of the chemical and electronic industries (Table 5.1).

Since the 1990s, research has been extended to the comparison between productivity performance in different types of ownership, mainly between the state and collective sectors over time. Using aggregated manufacturing data, Jefferson et al (1992) compared the TFP performance of the state-owned sector with the urban collectively owned sector, and found that TFP growth of the collective sector was 4.6 percent over the period 1980 to 1988, almost double that of the SOEs. Later (1996) they conducted a similar study using data for the industry as a whole from 1980 to 1992, and found a rising TFP trend for both the state and collective sector. However, there were persistent differences in TFP growth across ownership types. TFP growth in the collective sector outperformed the state sector by a considerable amount. These findings were questioned by Woo et al (1994). They compared two deflators: one

[5] The Industrial Census was conducted in 1985 and data were published in 1988, which contained information for three years, 1980, 1984, and 1985.

attributed to Jefferson et al (1992), and the other taken from 'official statistics'. They concluded that the difference between the two deflators indicated a probable upward bias in TFP estimates from 'overdeflation' of intermediate inputs.

Murakami, Lin, and Otsuka (1994) estimated a translog production function to compare efficiencies among five types of enterprises, namely, state-owned enterprises, urban-collective enterprises, independent township village enterprises, co-operative township village enterprises, and joint ventures. Their data was from a small sample survey of five types of firms in Shanghai, Beijing, and Guangzhou from 1985 to 1990. The value of machinery, rather than the value of total fixed capital for production, was used as a proxy for the total capital stock for production. They postulated efficiency in the following descending order: joint venture, co-operative TVEs, independent TVEs, urban collective firms, and state-owned firms.

Recognising the limitation of using aggregate data for state and non-state sectors, several attempts have been carried out to analyse the TFP performance of different industries in different ownership types. Perkins (1996) estimated a Tornqvist index of TFP growth in six industrial sectors from 1982 to 1992 by using 300 surveyed enterprises, and employing coefficients estimated from production functions. They constructed indices of TFP growth by taking 1980 as unity and studying the change in TFP growth. The results show joint venture and wholly foreign owned firms experienced the highest rate of productivity growth, followed by collective enterprises and the TVEs. State-owned firms had positive TFP growth but the lowest increase in productivity among the sectors studied. For industries, they conclude that the more labour intensive, export oriented and non-SOEs dominated industries had high TFP growth, while the capital intensive, domestically-oriented, and state dominated sectors had low TFP growth (Table 5.1).

Evidence showing that the collective sector is more efficient is not entirely consistent. McGuckin and Nguyen (1993) examined China's state-owned, collective, and private enterprises in twenty two manufacturing sectors, using 1985 census data and found that TFP growth was most significant in private enterprises, and that collective enterprises experienced a high rate of output growth due to their rapid growth of inputs, while their TFP growth was found to be similar to that of the state sector.

Parker (1994) used a generalised restricted cost function approach and employed aggregate data from twenty nine provinces for state and urban collective enterprises in the construction sector from 1985 to 1988. The results showed that while the TFP growth in both sectors was improving, the urban collective sector was less efficient than the state sector.

That results vary significantly from one another may be due to different data used, different methodologies employed, and different time periods covered. These differences limit the possibility of a direct comparison of calculated values of TFP growth across different studies. Thus, the absolute value of TFP growth results should be taken only as indicative rather than as being definitive. Gaps in data, as well as the differences in methods applied, ensures that controversy will continue over the construction and interpretation of productivity measurement. However, the relative TFP growth of different industries and different ownership reveals relatively consistent results and will provide valuable information for economic policies Some major studies are summarised in Table 5.1.

Table 5.1 Selected studies on TFP growth of the Chinese industry

Author	Model	Period	Sample	Weight	Deflators	TFP growth per annum (%)
Jefferson et al (1996)	Gross output, constant returns to scale	1980-1992	Total industry including mining and utilities in aggregate level; in state and collective sector of independent accounting firms	Estimated from production function	Output deflator is the ex-factory price; capital deflator is a combination of equipment and construction; intermediate inputs: purchase price index	State sector: 2.5 ; Collective sector: 3.43
Perkins (1996)	Gross output	1980-1992	189 surveyed enterprises in 4 coastal cities and 6 industries, including state sector, collective sector, joint ventures (JV) and wholly foreign owned enterprises (WFO)	Estimated from production function	Output and intermediate input: output price index. Capital: Subtract each year's investment and deflate by investment goods deflator then added back to obtain the real value	WFO and JV experienced highest TFP growth, followed by collective firms and SOEs. SOEs also had positive TFP growth .
T. Groves	Gross output	1980-	427 Firm level SOEs in five	Estimated from	Output and intermediate	Textile: 2.5

(1994)		1989	industries	production function	input: output price index; Capital is deflate by investment deflator	Chemical: 2.7 Building materials: 3.4 Machinery: 6.1 Electronics: 7.7 Overall: 4.5
E. Parker (1994)	Gross output	1985-1988	Aggregated data for state and urban collective sector from 29 provinces in the construction industry	Estimated from translog cost function	Output and intermediate input: output price index; Capital is decomposed into capital asset and net investment, and deflated by national price index for equipment	State sector is slightly more efficient than the urban collective sector
McGuckin et al (1992)	Using both gross and value added production function both with and without CRS	1980-1984 1984-1985	Aggregated data for 28 manufacturing industries from the 1895 industrial census	Estimated from production function	Output and intermediate input: output price index. Capital is deflated by output price index of 5 capital goods industries	1980-1984: TFP growth in 10 industries are positive. Overall TFP growth is negative; 1984-1985: TFP growth in 19 industries are greater than 0, overall TFP growth is positive.
Woo et al (1994)	Production functions for both net and gross output. Estimated translog production function, the coefficient of time is taken as TFP growth	1984-1988	300 large and medium sized SOEs and 200 TVEs in 4 industries and 10 provinces	N.A.	Output and intermediate input: output price index; Capital: deflate the investment of each year by investment deflator and add the real value of investment to previous year's capital stock	SOEs: negative or close to zero; TVEs: positive
Huang (1997)	Stochastic frontier production function for gross output	1980-1994	681 SOEs in 4 provinces in 6 industries	N.A.	Not reported	Food and beverage: 0.13 Textile: -2.02 Chemicals: 0.99 Building materials:-2.53 Machinery: 0.07 Electronics: 0.51

5.3 Sectoral and Ownership Comparisons of Productive Performance in the Chinese Manufacturing industry

5.3.1 Hypotheses

TFP growth is related to ownership through a number of mechanisms. In different categories, there may be differences in incentives, managerial performance, scale of production, and access to technology and credit. Considerable evidence has been gathered to show that SOEs are declining, though results from productivity studies have remained controversial. In 1995, SOEs still employed 67 percent of all industrial workers and accounted for 60 percent of total investment, despite a sharp decline in output share, from 76 percent in 1980 to 34 percent in 1995. The operation of the collective firms is to a large degree free from government regulation. In 1995, the collective sector employed 22 percent of industrial workers and held 18 percent of total assets while producing 37 percent of the total output.

The comparison between foreign and local firms is an area of great interest. There are a number of reasons to expect foreign firms to be more productive. MNCs investing in foreign countries are more likely to have access to efficient technologies, management skills, marketing networks, and incentive schemes. Since most FDI firms are export oriented, they cannot accomplish their objectives unless they are productive and competitive. Foreign exchange gives them the capability to purchase advanced technology. MNCs also possess more autonomy, because government regulations in their management are largely absent.

Therefore, it is hypothesised that the state sector has the lowest TFP growth of the three sectors. Compared with state-owned enterprises, collective firms are expected to be more efficient and have a higher TFP growth. The sector with FDI is expected to have the highest TFP growth among the three sectors considered. The hypothesis with regard to industry TFP difference is not straightforward. No null hypothesis is therefore attached to TFP comparisons between industries.

5.3.2 Methodology

5.3.2.1 Issues Related to the Measurement of TFP Growth in China

Previous studies highlight the following issues to be clarified regarding the measurement of TFP growth in Chinese industry.

Weight of each input

The weight of each input can be estimated from the output elasticity of each input or be substituted by the factor share under competitive market and profit maximisation assumptions. In China, the correspondence between factor shares and marginal productivity is not likely to apply (Perkins 1996). Even with the economic reform, Chinese markets are far from competitive. For this reason, when estimating TFP growth, direct estimate of the output elasticity of each input in each industry is more appropriate than using cost shares.

Value added or gross output

The condition for being able to use value added, capital and labour as inputs is that capital and labour are weakly separable from intermediate inputs. When this condition is satisfied, there are no strong theoretical guidelines as to whether gross output with three inputs or value added with two inputs should be used. However, in practice, the value added model is often preferred when the analysis is undertaken at an aggregated level. At this level, double counting problems in the gross output measure are unavoidable, because the output in one industry is often purchased by another for assembly into final goods. Therefore, this study employs value added, with capital and labour as inputs, because it deals with aggregated industry level data.

Adjusting for the non-productive inputs

One of the problems with the Chinese data is the over-statement of capital and labour inputs in the production process. Chinese state enterprises provide a variety of welfare and other services to employees. Their capital data include residential construction and other non-productive investment for service facilities, such as housing, schools, and clinics. The same problem exists with the labour data. Some (e.g. Chen et al, 1988) have argued that an accurate assessment of production efficiency requires that capital and labour not directly used in the production process be excluded, and attempt to make some adjustment by making a crude allowance of capital and labour.

Such adjustment is fraught with uncertainties, given that there is no detailed information available on the proportion of non-production inputs. Sachs and Woo (1994); and Woo et al. (1994) pointed out that enterprises could not have supplied the observed output had they not provided social services to their workers. In the absence of well functioning markets in housing, medical services, and education, SOEs had to provide these services in order to enable production workers to participate in the production process. A complete absence of social service would have had an adverse effect on production, so that only some of the complementary capital and labour should be excluded. This suggests it may not be a useful exercise to make the adjustment unless detailed information is available. Some bias is unavoidable using unadjusted data, but a crude adjustment may not necessarily be an improvement. As a result, this study is employing data for capital and labour which has not been adjusted to exclude the non-productive portion.

Measurement of capital stock

The conventional Chinese way of calculating the current year's capital stock is to add up net investment undertaken each year according to the current price of the corresponding year. To correct this bias, undeflated investment undertaken each year should be subtracted from capital stock data and deflated, using the corresponding year's capital stock deflators. The deflated investment data should then be added back into capital stock data and depreciation subtracted to obtain real capital stock data (Perkins 1996). In this study, information on the portion of each year's investment in the total capital stock was not available. Therefore, the total capital stock of each year is directly deflated by the price index of capital goods of that year. Given that the purpose of this study is to compare TFP performance of firms in different industry and ownership types, and given that only three years are covered in the data set, the bias of deflating capital stock by this method is not expected to be serious.

Value added deflators

The estimation of TFP growth is extremely sensitive to errors in the deflation of current prices of output and inputs. The deflator which often causes controversy is value added. Value added should be dual deflated by price indices of gross output and intermediate input respectively. Most studies, however, obtain real value added in the industrial sector by deflating the nominal value added with a gross output deflator. Since materials occupy a large share of output value, the estimate of TFP growth is highly sensitive to the price trend for materials.

Woo et al (1994) point out that measurement of input prices is the weakest part of the TFP estimates in China. However, with better and more data on various price indexes published, the situation is improving. In this study, price deflators were obtained for intermediate inputs. Deflating the inputs by their own price deflators helps avoid some bias arising from the inconsistent change in relative prices when using the output deflator as proxies for input deflators.

Frontier or ordinary production function

The complexity of the Chinese economy indicates there is no common frontier for firms in different industry and ownership categories. In addition, the frontier is a concept for firms rather than for industries, which implies that the frontier production procedure is inappropriate for industry level studies.

5.3.2.2 The derivation of the Tornqvist index

For the reasons outlined, there are two steps involved in the estimation of TFP growth in Chinese industry. The first step involves estimating the production function for each industry in each ownership category. The output elasticity of labour and capital in each industry, estimated from the production function exercise, is then used as the weight to estimate the Tornqvist index of TFP growth in various industrial sectors in the three ownership categories. To analyse the industry and ownership differences of TFP growth, the production function and the TFP growth index is calculated for 28 industries in the state, collective, and FDI sectors respectively. The Tornqvist index of TFP growth is derived as follows;

let the production function be represented by $Y = Y(K, L, t)$, where Y is value added and K and L denote capital and labour respectively. Taking the logarithm form and totally differentiating the production function with respect to time, it becomes,

$$(5.3) \quad dLnY / dt = (\partial LnY(K,L,t) / \partial Y) * (\partial Y(K,L,t) / \partial t)$$
$$+ (\partial LnY(K,L,t) / \partial K) * (d K / d t)$$
$$+ (\partial LnY(K,L,t) / \partial L) * (d L / d t)$$
$$= (1 / Y) * (\partial Y / \partial t) + \varepsilon_k (d K / d t) / K + \varepsilon_l (d L / d t) / L,$$

where ε_k and ε_l are the output elasticities of capital and labour. The TFP growth index TFPG is defined as follows:

$$(5.4) \quad TFPG = (1 / Y) * (\partial Y / \partial t)$$
$$= dLnY / dt - \varepsilon_k (dK / dt) / K - \varepsilon_l (dL / dt) / L$$
$$= dLnY / dt - \varepsilon_k dLnK / dt - \varepsilon_l dLnL / dt .$$

This expression is called the Divisia index of TFP growth. If there are competitive markets and firms are profit maximisers, the output elasticities are equal to the cost share of each input in total revenue, that is,

$$(5.5) \quad \varepsilon_i = (\partial Y / \partial X_i) / (Y / X_i) = P_i X_i / PY,$$

where P_i is the price of input i, X_i is input i, P is the price of output, and Y is output.

Under discrete time:

$$(5.6) \quad TFPG = (LnY_t - LnY_{(t-1)}) - \sum_i (1/2)(\varepsilon_{it} + \varepsilon_{(it-1)}(LnX_{it} - LnX_{(it-1)}) .$$

This is known as the Tornqvist approximation of the Divisia index.

5.3.3 Data

Industrial level data on 28 manufacturing industries for 20 provinces has been used to carry out the estimation.[6] There are forty industries in the standard Chinese statistical yearbook which approximately corresponds to the two digit Standard International Trade Classification (SITC). These statistics are published for thirty provinces. However, 9 industries in the mining and utility sectors are not included. Three manufacturing industries and data for ten provinces are not included because data for some important variables are not available. The data set has been restricted to three years because data for the FDI variable is only available for the period 1993 to 1995. A panel data set has been formed for each industry in each ownership category which includes sixty observations. The results from different industries and different ownership categories has been compared to examine industry and ownership differences of TFP growth. The main variables are measured as follows:

Gross output value. Data for the gross output value has been taken from various issues of the provincial Statistical Yearbook of China. These data are available in current prices. The gross output value in the 1990 constant price is obtained by deflating the value in current prices according to the output price deflator. The deflator is chosen as the producer price index for each industry. The output price index is available in the China Statistical Yearbook (1997, p.282).

Intermediate input. The value of intermediate input in current price is obtained by the difference between the gross output and value added in current price. The value of intermediate input in constant prices is calculated by deflating the current value by the intermediate inputs price index which is published in China Economic Yearbook (1996, P. 875). Using the price index for intermediate inputs avoids the bias of most previous studies which deflate intermediate inputs by an output price index.

Value added. Data on value added in current prices are available from the provincial Statistical Yearbook of China. These data were not used in this study. Since deflating value added directly by an output price index involves the same bias as

[6] Industries and provinces are listed in appendix 5.1.

deflating intermediate inputs by output price index, the value added figure of constant prices has been obtained by taking the difference between the value of gross output and intermediate input, each in constant prices, as described above.

Capital input. Data on capital stock are represented by the net value of fixed assets which has been obtained by using the widely used perpetual inventory method. However, each year's investment is valued at current price, and the original capital asset valued at original purchase prices. To obtain the real value of capital input, it is necessary to deflate the original value of capital asset and each year's investment by the corresponding capital goods price deflators of each year. However, for the reasons mentioned above, the total capital stock of each year is directly deflated by the price index of capital goods of each year. Since there is no industry and provincial specific asset deflators available, the study uses a uniform capital stock deflator. The capital price index in available form various issues of China Statistical Yearbook.

Labour input. Labour input is measured by the total number of employees in each industry.

5.3.4 Estimation of TFP Growth in Chinese Industry

5.3.4.1 Estimation Of the Production Function and the Output Elasticity for Each Input

Several functional forms can be assumed to evaluate industrial performance in China. When there are no theoretical guidelines, one simple method to determine which production function is appropriate is to choose a more general functional form and test the hypothesis whether one or more alternative forms hold. Various production function specifications were explored, including the flexible translog production function with and without constant returns to scale constraint, and the Cobb-Douglas production function with and without constant returns to scale constraints. Model specification tests such as Ramsey's (1969) RESET test and the F-test indicated that the Cobb-Douglas production function is the appropriate form for all the industries.

These results are consistent with previous studies on the production function of Chinese industries (Chow 1993; Jia 1991; Perkins 1996; Wan 1995).

The affirmation that the Cobb-Douglas production function is the appropriate form indicate that the inputs are strongly separable. Separability tests indicated the same results.[7] This implies that it is theoretically valid to use value added with capital and labour as inputs to estimate TFP growth. Thus, value added has been chosen with capital and labour as inputs to estimate the TFP growth because it avoids double counting problems. F-tests also show that constant returns to scale prevail in most industries. However, for some industries, production function without constant returns scale restrictions are chosen when F-tests reject the hypothesis. In most industries, the coefficient for capital in the state sector is larger than for the collective and FDI sector. This result may reflect the fact that the state sector is over-staffed and the marginal product of labour is low. The results of the estimated production function for 28 industries in state, collective, and FDI category are reported in appendix 5.2.

5.3.4.2 The Results of TFP Growth

Table 5.2 presents the results of TFP growth calculated using the Tornqvist index.

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[7]For a production process utilizing N inputs, separability of inputs X_1 and X_2 from other inputs implies that the marginal rate of substitution between X_1 and X_2 is independent of the level of the other *(N-2)* factors. Following Denny and Fuss (1977), the condition for the separability of capital, labour, and intermediate input of the following translog production function are given by the following restrictions on the parameters:

$$\mathrm{Ln}\,Y = \alpha\,\mathrm{Ln}K + \beta \mathrm{Ln}L + \rho\,\mathrm{Ln}\,M + \tfrac{1}{2}(\beta_{KK})(\mathrm{Ln}K)^2 + \tfrac{1}{2}(\beta_{ll})(\mathrm{Ln}L)^2 + \tfrac{1}{2}(\beta_{mm})(\mathrm{Ln}M)^2$$
$$+ (\beta_{kl})(\mathrm{Ln}K)(\mathrm{Ln}L) + (\beta_{km})(\mathrm{Ln}K)(\mathrm{Ln}M) + (\beta_{lm})(\mathrm{Ln}L)(\mathrm{Ln}M)$$

Separability means the following conditions hold:

Weak separability	$\alpha / \beta = \beta_{km} / \beta_{lm}$
Partial strong separability	$\beta_{km} = \beta_{lm} = 0$
Complete strong separability	$\beta_{KK} = \beta_{ll} = \beta_{mm} = \beta_{kl} = \beta_{km} = \beta_{lm} = 0$, i.e. Cobb-Douglas production function.

Table 5.2 TFP growth of the Chinese manufacturing industries (percent per annum)

Industries	Name of industries	All	SOE	collective	FDI	difference of TFP growth (All-FDI)	difference of TFP growth (SOE-FDI)	difference of TFP growth (Collective-FDI)
1	food processing	-5.37	-8.20	-0.87	2.14	-7.51	-10.34	-3.01
2	food manufacturing	-2.97	-6.58	-0.33	5.37	-8.34	-11.95	-5.70
3	beverage manufacturing	-1.66	-3.47	-3.09	0.61	-2.27	-4.08	-3.70
4	tobacco processing	-1.05	-2.00	-4.96	7.82	-8.87	-9.82	-12.78
5	textile industry	-6.60	-8.38	-1.86	2.86	-9.46	-11.24	-4.72
6	garment and other fibre products	0.50	-4.42	2.21	6.57	-6.07	-10.99	-4.36
7	leather, furs, down	-2.64	-9.44	1.11	6.92	-9.56	-16.36	-5.81
8	timber processing, bamboo, cane, palm fibre and straw products	2.02	-2.00	9.69	7.77	-5.75	-9.77	1.92
9	furniture	10.00	0.59	10.04	8.08	1.92	-7.49	1.96
10	paper making and paper products	3.52	4.47	2.77	3.72	-0.20	0.75	-0.95
11	printing and record pressing	-5.51	-6.44	4.40	-0.99	-4.52	-5.45	5.39
12	cultural, educational, and sports articles	8.80	-6.34	9.70	10.70	-1.90	-17.04	-1.00
13	petroleum processing and coking products	4.26	8.22	-0.84	-0.73	4.99	8.95	-0.11
14	raw chemical materials and chemical products	-1.62	-0.61	1.53	9.06	-10.68	-9.67	-7.53
15	medical and pharmaceutical	-4.95	-6.71	-3.95	4.78	-9.73	-11.49	-8.73
16	chemical fibres	-3.36	-6.18	-1.06	-8.64	5.28	2.46	7.58
17	rubber products	-6.58	-8.96	-0.51	-7.02	0.44	-1.94	6.51
18	plastic products	-1.63	-6.91	1.11	5.46	-7.09	-12.37	-4.35
19	non-metal mineral	-2.75	-5.65	3.38	7.70	-10.45	-13.35	-4.32
20	smelting and processing of ferrous metals	-7.26	-7.44	-3.35	8.87	-16.13	-16.31	-12.22
21	smelting and processing of non-ferrous metals	-0.73	-0.62	0.77	9.44	-10.17	-10.06	-8.67
22	metal products	-0.38	-2.81	3.89	9.65	-10.03	-12.46	-5.76
23	ordinary machinery	-3.00	-3.50	1.99	4.59	-7.59	-8.09	-2.60
24	special purposes equipment	-1.88	-1.39	2.30	4.00	-5.88	-5.39	-1.70
25	transportation equipment	0.21	-5.18	4.19	3.68	-3.47	-8.86	0.51
26	electric equipment and machinery	5.69	-6.11	6.01	8.76	-3.07	-14.87	-2.75
27	electronic and telecommunications	9.74	2.13	7.34	9.97	-0.23	-7.84	-2.63
28	instruments, meters, cultural and office machinery	-2.12	-4.28	-2.48	5.86	-7.98	-10.14	-8.34
29	Average	-0.62	-3.86	1.75	4.89	-5.51	-8.76	-3.14

The magnitude of TFP growth rate for some industries is large probably due to the fact that this study uses value added and capital and labour to conduct the calculation. Domas (1961) has shown that exclusion of intermediate materials from both sides of the production equation exaggerates the TFP growth index. McGuckin et al. (1992) found that the magnitude of both TFP decline and TFP growth obtained from the value added framework is larger than that from the gross output framework.

The overall conclusion drawn from these results is that there are substantial differences in TFP growth between ownership categories. The sector with FDI experienced the highest TFP growth from 1993 to 1995, averaging 4.89 percent per annum, followed by the collective sector, with an average TFP growth of 1.75 percent per annum. The average TFP growth for the state sector is -3.86 percent per annum, the lowest of the three sectors, and overall[8] TFP growth averages -0.62 percent. Despite some differences in values, the results are consistent with most previous studies which indicate the state sector has experienced a negative TFP growth, and the collective sector has had a moderate TFP growth rate. There are few studies on TFP growth for industries with FDI in China, the results from this study show that FDI is the most dynamic sector in terms of productivity growth in China.

Significant inter-industry differences in TFP growth in the aggregated manufacturing level were also observed. Overall, the industries that experienced the lowest TFP growth are smelting and processing of ferrous metals; textile industry; printing and recording pressing; food processing; medical and pharmaceutical products; chemical fibres; ordinary machinery; food manufacturing; non-metal mineral product; and smelting and processing of non-ferrous metal. The industries with the highest TFP growth are furniture manufacturing; electronic and telecommunications equipment, cultural, educational, and sports articles; electric equipment and machinery.

There are many reasons behind the inter-industry differences of TFP growth difference. Correlation analysis (Table 5.3) indicates that industries with a higher

[8] The results for all the industries are different from the average of TFP growth for state, collective, and FDI sector for the reason that all industries include other sectors such as share holding companies, private firms, and joint ventures between domestic firms.

SOE presence tend to have low TFP growth. This should be expected because the state industries have relatively low TFP growth.

Table 5.3 Correlation coefficient between TFP growth and output share

(By ownership categories)

	TFP (All)	TFP (SOE)	TFP (Collective)	TFP (FDI)	output share of SOE	output share of Collective	output share of FDI
TFP(all)	1.00						
TFP(SOE)	0.59	1.00					
TFP(Collective)	0.72	0.21	1.00				
TFP(FDI)	0.43	0.15	0.37	1.00			
output share(SOE)	-0.33	0.27	-0.64	-0.23	1.00		
output share(collective)	0.10	-0.23	0.57	0.15	-0.77	1.00	
output share(FDI)	0.53	-0.06	0.47	0.22	-0.68	0.09	1.00

The inter-industry difference in TFP growth reveals different patterns in each ownership category. Only four industries in the state sector recorded positive TFP growth.. These industries are petroleum processing and coking products, paper making and paper products, electronic and telecommunications, and furniture industry. Taking the differences of the TFP growth between industries in the state sector and industries in the FDI sector, only petroleum industry recorded a higher TFP growth than the corresponding industry in the FDI sector. The petroleum industry is dominated by large scale state-owned enterprises and has always been considered one of the key sectors in the Chinese economy. The high TFP growth may come from the continued effort toward technology development in these large firms.

Seventeen industries in the collective sector recorded positive TFP growth. The industries with the highest TFP growth are furniture industries; cultural, educational, and sports articles; timber processing, bamboo, cane, palm fibre, and straw products; electric equipment and machinery; and printing and recording pressing. These industries are mainly labour intensive and consumer product industries. Collective industries have shown considerable advantage and vitality in utilising China's cheap labour and have been efficient and competitive. Compared with the FDI industries, the collective sector has higher TFP growth in timber processing, bamboo, cane, palm fibre, and straw products; furniture manufacturing; paper making and paper product; printing and record pressing; chemical fibres; and rubber products. This result highlight collective firms' competitiveness in labour intensive industries.

The industries in the collective sector recording the lowest TFP growth were tobacco; medical and pharmaceutical; smelting and processing of ferrous metal; beverage industry; and instrument, meters, and office machinery. Except for the tobacco and beverage industries, which have been based on consumer tastes for traditional SOE products and, in recent years for foreign products, these industries are more capital and technology intensive. Collective firms, which are generally small and labour intensive, have not been showing high TFP growth in these industries.

Four industries in the FDI sector showed negative TFP growth. These are chemical fibres; petroleum processing and coking products; rubber products; and printing and recording products. The industries in this sector with the highest TFP growth are cultural, educational, and sports articles; electronic and telecommunications; metal products; smelting and processing of ferrous metal; electric and machinery; and furniture. These industries are more export oriented and compete in the international market. Overall, the FDI sector showed high TFP growth in most industries in the Chinese economy.

Despite the different distribution of TFP growth in different ownership categories, there are several common features worth noting. The first is that food and beverage industries across all ownership types experienced relatively low TFP growth. This finding seems to be a common phenomenon. Timmer and Szirmai (1997) found productivity levels in the food, beverage, and tobacco industries to be well below the average in five Asian countries studied (China, India, Indonesia, Taiwan, Korea). Salim (1996) found negative TFP growth in the Bangladesh food industry during the early 1980s. The reason for the poor performance of the food and beverage industries might be because of the limited scope for technological progress in these industries. These are mainly labour intensive industries serving the local market based on consumer taste and loyalties, and the output increase is mainly from increased inputs.

The second feature is that consistent with some previous studies on industry TFP differences (Perkins 1996), the textile industry has shown low TFP growth. Thirdly, the textile sector is dominated by SOEs which have performed poorly during the last decades. The electronic and telecommunication industry had positive TFP growth in all ownership categories and especially in the FDI and the collective sector. This industry has a high proportion of non-state firms and is highly market oriented, competing in both the domestic and international markets. Despite the fact that these industries can have high-tech ingredient, the electronics industries in China is a labour intensive assembling operation with mature standard technology. These technologies, however, are appropriate for the current economic development of China and have shown considerable comparative advantage in the international market.

Table 5.4. Correlation between TFP growth and capital labour ratio

	TFP (All)	TFP (SOE)	TFP (Collective)	TFP (FDI)	capital labour ratio (All)	capital labour ratio (SOE)	capital labour ratio (collective)	Capital labour ratio (FDI)
TFP(all)	1.00							
TFP(SOE)	0.59	1.00						
TFP(Collective)	0.72	0.21	1.00					
TFP(FDI)	0.43	0.15	0.37	1.00				
capital labour ratio (All)	-0.08	0.27	-0.47	-0.39	1.00			
capital labour ratio (SOE)	-0.17	0.26	-0.53	-0.31	0.97	1.00		
capital labour ratio (collective)	-0.15	-0.10	-0.27	-0.50	0.77	0.67	1.00	
Capital labour ratio (FDI)	-0.12	0.31	-0.42	-0.39	0.88	0.85	0.67	1.00

Correlation analysis (Table 5.4) shows that industries with high capital labour ratio tend to have low TFP growth in the collective sector and FDI sector. However, there is a tendency in the state sector that TFP growth is positively related to its capital labour ratio. This feature is closely related to the fact that the government had allocated a large amount of capital into the state sector, particularly into SOEs in capital intensive industries. For the capital intensive industries in the state sector, capital is vastly undervalued, thus making the published figures of capital input lower than they otherwise might be. Since lower than actual capital figures are used in the calculation, higher TFP growth is observed.[9]

Overall, industries in the FDI sector presented the highest TFP growth, followed by industries in the collective sector. Industries in the state owned sector experienced the lowest TFP growth. For the non-state owned sectors, the results suggests that the more labour intensive industries have higher TFP growth. Ownership and capital ratio are important determinants of TFP growth, however, the observed TFP growth differences across industries and ownership categories cannot be explained by these two factors alone. Studies show TFP growth is determined by various factors. These may include participation of international competition, R&D intensity, and national industry policies. To explore the determinants of TFP growth, a more comprehensive model is therefore required.

5.4 Conclusions

With the objective of comparing the productive performance of Chinese manufacturing in different industries and with different ownership characteristics, this study has investigated the TFP growth rate of 28 Chinese manufacturing industries in the state, collective and FDI sectors. The investigation was carried out by obtaining output elasticities, through estimating production functions in each industry and each ownership category. A growth accounting study was then conducted by using elasticities estimated from the production function. Given the differences in TFP growth for sectors with different industries and ownership characteristics, this study provides useful insights for analysing the productivity growth of Chinese industry.

This study found that great differences exist between the productive performance of industries in different ownership categories. Sectors with FDI experienced the highest TFP growth, followed by the collective sector. With some exceptions, manufacturing industries in the state sector have not closed the gap between themselves and FDI sector in recent years. Most industries in the state sector experienced negative or stagnant TFP growth.

[9] Despite these industry differences within the state sector, state owned industries generally have low TFP growth compared with those in non-state sectors.

Consistent with many previous studies, the result of this study verified the hypothesis that high TFP growth is associated with non-state ownership. In an aggregated level, industries with a higher output proportion of non-state sector also tend to have higher TFP growth. The ownership difference of TFP growth suggest that firms which are operating in a market environment are more likely to have high TFP growth. This further suggests that policies to increase autonomy of state-owned enterprises by eliminating government control would be beneficial for their TFP growth. The significantly poorer productivity growth performance of SOEs also indicates the importance of freer entry for non-state firms. Lessening the institutional constraints which disadvantage non-state-owned firms will allow them to behave towards best practice. Therefore, continued industrial reforms can be expected to contribute to improved economic growth performance of domestic firms.

The industry comparison of TFP growth provides confirmation of considerable industry differences. A major feature regarding industry TFP growth is that there is a tendency for industries with high capital labour ratio to experience low TFP growth in the collective and FDI sectors. The TFP growth gap between domestic and FDI firms is also higher in capital intensive industries. The implication for this finding is that the government's effort to develop capital intensive industries may not be a rational measure at the early stage of development.

The study suggests that FDI contributes positively to the national economy in terms of productivity growth. The higher TFP growth of the FDI sector provides the potential for spillovers to take place. As a part of the Chinese economy, FDI also pushes up overall productive performance of the economy as a whole.

The indices of TFP growth can indicate the difference of growth, but it is not the source of growth itself. As the 1991 World Development Report (8:4) points out: 'Growing productivity is the engine of development. But what drives productivity? The answer is technological progress, which in turn is influenced by history, culture, education, institutions and policies for openness in developing and industrial countries.' Finding the source of TFP growth and, especially, exploring the effect of the existence of FDI on domestic firms TFP growth is the task of the following two chapters.

Appendix 5.1 Name of Industries and Provinces

Industries

1. Food Processing industry
2. Food Manufacturing industry
3. Beverage Manufacturing industry
4. Tobacco industry
5. Textile industry
6. Garment and fibre products
7. Leather, fur, down. and related products
8. Wood, bamboo, cane, palm, and straw products
9. Furniture manufacturing
10. Paper making and paper products
11. Printing and record pressing
12. Cultural, educational. And sports articles
13. Petroleum processing and coking products
14. Raw chemical materials and chemical products
15. Medical and pharmaceutical products
16. Chemical fibres
17. Rubber products
18. Plastic products
19. Non-metal mineral products
20. Smelting and processing of ferrous metal
21. Smelting and processing of non-ferrous metal
22. Metal products
23. Ordinary machinery
24. Special purpose equipment manufacturing
25. Transportation equipment manufacturing
26. Electric equipment and machinery

27. Electronic and telecommunication

28. Instruments. Meters, cultural and office machinery

Provinces

Hebei, Shanxi; Heilongjinag; Shanghai, Jiangsu, Zhejiang, Aihui, Fujiang, Jiangxi, shandong; Henan, Guangdong, Shenzhen, Guangxi, Hainan; Yunnan; Sichuan; Guizhou, Qinhai, and Shanxi.

Appendix 5.2. The estimated production functions for the Chinese manufacturing industries

Table 5A.1 Production function estimation for industries - all sectors combined

Variables / industries *	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ln K	0.816 (10.590)	0.582 (5.099)	0.643 (6.290)	0.790 (6.025)	0.882 (8.521)	0.702 (7.192)	0.396 (2.451)	0.568 (6.401)	0.479 (5.308)	0.8728 (8.429)	0.820 (10.630)	0.511 (5.858)	0.482 (3.112)	0.992 (9.884)
Ln L	0.112 (0.853)	0.417 (3.648)	0.224 (2.543)	0.149 (1.404)	0.238 (2.361)	0.297 (3.046)	0.603 (3.724)	0.431 (4.86)	0.520 (5.756)	0.052 (0.526)	0.179 (2.322)	0.488 (5.597)	0.517 (3.341)	0.008 (0.078)
Constant	2.560 (2.257)	0.829 (2.569)	1.742 (2.523)	2.202 3.181	-1.937 (-3.24)	0.024 (0.129)	0.208 (0.514)	0.561 (1.802)	0.664 (3.277)	0.076 (0.161)	-0.126 (-0.559)	0.970 (4.853)	0.674 1.167	-1.666 (-4.472)
F-statistics for testing CRS *	5.563	0.755	5.430	4.2029	6.789	0.129	0.578	0.104	1.498	4.767	0.544	0.532	2.310	3.085
R^2 - adjusted	0.706	0.906	0.920	0.932	0.957	0.975	0.945	0.934	0.927	0.957	0.931	0.981	0.901	0.954
Variables / industries *	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Ln K	0.957 (11.671)	0.600 (4.803)	0.547 (3.830)	0.483 (5.005)	0.757 (13.28)	0.615 (5.403)	0.824 (6.784)	0.676 (7.179)	1.146 (8.62)	1.047 (19.31)	0.763 (6.967)	0.475 (4.544)	0.600 (3.855)	0.709 (4.304)
Ln L	0.042 (0.512)	0.399 (3.193)	0.452 (3.160)	0.690 (3.951)	0.242 (4.253)	0.384 (3.381)	0.176 (1.441)	0.437 (3.865)	0.009 (0.07)	0.003 (0.057)	0.236 (2.156)	0.690 (5.923)	0.673 (3.725)	0.455 (2.511)
Constant	1.467 (5.609)	0.989 (1.737)	-0.317 (-0.956)	-1.350 (-2.87)	-0.442 (-2.16)	0.684 (1.502)	-0.270 (-0.46)	-0.727 (-1.419)	-2.606 (-3.79)	-0.553 (-1.18)	-0.815 (-2.701)	-0.734 (-1.86)	-1.893 (-3.34)	-0.537 (-1.024)
R^2 asjusted	0.925	0.888	0.949	0.969	0.955	0.880	0.919	0.948	0.949	0.967	0.936	0.973	0.952	0.942
F-statistics for testing CRS	0.007	0.595	-1.384	14.807	-0.236	2.071	0.722	4.784	11.091	2.163	0.031	17.316	18.728	10.692

Note: (1) t-ratios are in parenthesis. Number of observations for each indusry is 60.

Table 5A.2 Production function estimation for state-owned industries

Variables / industries *	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Ln K	0.935 (9.970)	0.964 (9.212)	0.834 (6.762)	0.779 (6.235)	0.943 (8.495)	0.854 (8.025)	0.528 (2.591)	0.378 (2.797)	0.659 (6.678)	0.975 (11.770)	0.729 (5.626)	0.418 (3.302)	0.647 (4.871)	0.976 (12.21)
Ln L	0.065 (0.693)	0.035 (0.337)	0.165 (1.338)	0.119 (1.448)	0.056 (0.505)	0.145 (1.362)	0.471 (2.311)	0.434 (3.598)	0.340 (3.445)	0.024 (0.2961)	0.058 (0.703)	0.581 (4.583)	0.353 (2.661)	0.023 (0.288)
Constant	-0.162 (-0.440)	-0.351 (-0.959)	0.174 (0.404)	2.501 (3.402)	-0.881 (-2.524)	-0.257 (-0.62)	-0.098 (-0.14)	2.369 (2.919)	0.630 (1.275)	-0.831 (-3.208)	1.515 (1.823)	0.394 (0.896)	-0.670 (-1.194)	-1.685 (-5.184)
R^2 asjusted	0.754	0.816	0.889	0.932	0.951	0.860	0.693	0.814	0.867	0.941	0.867	0.892	0.906	0.953
F-statistics for testing CRS	0.013	1.927	0.036	4.701	0.109	24.856	3.947	7.736	1.258	0.014	8.061	1.185	0.085	0.472
Variables / industries *	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Ln K	0.994 (15.292)	0.751 (11.60)	0.775 (5.208)	0.537 (4.088)	0.956 22.232	0.605 (6.612)	0.651 (6.385)	0.945 (8.793)	0.791 (7.690)	0.955 (21.130)	0.894 (9.553)	0.853 (10.500)	0.968 (9.680)	0.803 (6.116)
Ln L	0.005 (0.760)	0.248 (3.838)	0.224 (1.507)	0.314 (3.188)	0.009 0.583	0.394 (4.302)	0.348 (3.416)	0.0541 (0.503)	0.226 (2.252)	0.044 (0.983)	0.105 (1.123)	0.146 (1.795)	0.031 (0.310)	0.196 (1.491)
Constant	1.371 (5.715)	0.029 (0.088)	-0.621 (-1.239)	0.826 (0.903)	-0.657 (-1.211)	0.739 (1.682)	0.493 (0.883)	-0.348 (-0.929)	-0.158 (-0.412)	-0.049 (-0.292)	-1.170 (-3.598)	-0.326 (-1.275)	0.3984 (1.259)	0.380 (0.874)
R^2 asjusted	0.902	0.906	0.859	0.836	0.912	0.913	0.9036	0.779	0.900	0.961	0.901	0.945	0.896	0.910
F-statistics for testing CRS	1.1438	2.324	0.147	4.921	4.043	0.067	1.362	1.697	8.043	2.252	0.020	1.033	0.659	0.096

Note: (1) t-ratios are in parenthesis. Number of observations for each indusry is 60.

Table 5.A3 Production function estimation for collective industries

Variables / industries *	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ln K	0.693 (7.850)	0.724 (12.19)	0.410 (4.277)	0.986 (8.507)	0.584 (8.590)	0.620 (10.44)	0.740 (9.381)	0.728 (13.500)	0.604 (8.307)	0.804 (14.390)	0.582 (9.562)	0.595 (5.878)	0.800 (6.744)	0.517 (4.834)
Ln L	0.306 (3.463)	0.275 (4.629)	0.387 (4.667)	0.014 (0.120)	0.415 (6.095)	0.380 (6.395)	0.259 (3.282)	0.271 (5.021)	0.395 (5.432)	0.195 (3.500)	0.323 (5.169)	0.590 (4.327)	0.199 (1.679)	0.482 (4.500)
Constant	0.949 (3.280)	1.057 (5.052)	1.336 (2.400)	0.443 (0.849)	-0.296 (-1.18)	0.018 (0.090)	-0.183 (-0.71)	0.202 (1.073)	0.559 (2.202)	-0.188 (-1.027)	1.298 (3.961)	0.260 (0.629)	-0.308 (-0.627)	0.611 (1.516)
R^2 asjusted	0.955	0.974	0.921	0.834	0.973	0.962	0.951	0.981	0.895	0.978	0.963	0.951	0.879	0.936
F- statistics for testing CRS	2.4169	0.5052	11.867	0.0165	14.231	3.277	0.054	0.009	0.031	1.879	8.222	9.834	1.6399	0.001
Variables / industries *	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Ln K	0.657 (9.771)	0.745 (10.22)	0.744 (10.42)	0.745 (11.04)	0.507 (7.257)	0.808 (11.45)	0.796 (11.12)	0.588 (8.846)	0.853 (17.86)	0.735 (14.190)	0.615 (7.519)	0.637 (11.63 0)	0.518 (4.797)	0.534 (7.348)
Ln L	0.342 (5.088)	0.254 (3.493)	0.481 (5.428)	0.254 (3.769)	0.352 (5.339)	0.191 (2.710)	0.203 (2.837)	0.412 (6.189)	0.192 (3.919)	0.387 (6.732)	0.384 (4.701)	0.509 (7.607)	0.722 (5.450)	0.465 (6.393)
Constant	0.979 (3.779)	0.579 (1.154)	-2.281 (-5.85)	0.089 (0.424)	1.557 (4.006)	0.253 (0.871)	-0.117 (-0.37)	0.520 (2.313)	0.067 (0.280)	-0.465 (-1.192)	-0.279 (-0.913)	-0.341 (-1.31)	-0.921 (-1.542)	1.046 (3.674)
R^2 asjusted	0.948	0.941	0.969	0.968	0.964	0.915	0.900	0.950	0.988	0.980	0.945	0.985	0.959	0.936
F- statistics for testing CRS	1.826	0.070	4.599	0.1648	22.959	2.969	0.916	0.598	3.623	17.202	2.396	25.267	20.2954	0.1643

Note: (1) t-ratios are in parenthesis. Number of observations for each indusry is 60.

Table 5A.4 Production function estimation for FDI industries

Variables / industries *	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ln K	0.543 (4.857)	0.535 (5.600)	0.778 (7.010)	0.676 (4.769)	0.594 (7.307)	0.539 (5.828)	0.568 (4.448)	0.719 (5.290)	0.359 (3.128)	0.398 (3.327)	0.620 (6.879)	0.571 (7.795)	0.806 (8.963)	0.540 (4.974)
Ln L	0.457 (3.103)	0.464 (4.729)	0.222 (1.995)	0.338 (0.101)	0.406 (1.892)	0.531 (3.409)	0.452 (3.072)	0.438 (2.647)	0.641 (5.585)	0.601 (5.022)	0.341 (1.869)	0.429 (0.227)	0.194 (1.928)	0.558 (4.078)
constant	0.262 (0.516)	1.068 (1.159)	1.973 (4.678)	1.335 (2.248)	1.769 (3.543)	0.118 (0.207)	0.283 (0.490)	0.308 (0.608)	0.961 (2.963)	0.0618 (0.135)	1.787 (2.868)	1.198 (1.420)	0.523 (0.814)	0.658 (1.216)
R^2- adjusted	0.856	0.939	0.967	0.703	0.973	0.953	0.963	0.914	0.950	0.950	0.897	0.928	0.752	0.940
F- statistics for testing CRS	1.434	0.091	3.751	4.0394	0.1718	4.588	4.5146	5.719	0.0419	0.0488	6.697	0.9842	0.7729	4.142
Variables / industries *	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Ln K	0.894 (5.211)	0.525 (3.208)	0.698 (9.812)	0.589 (5.303)	0.590 (6.681)	0.741 (7.641)	0.705 (7.484)	0.597 (4.708)	0.495 (2.508)	0.618 (6.763)	0.619 (4.208)	0.669 (6.450)	0.654 (3.499)	0.435 (1.114)
Ln L	0.549 (2.815)	0.618 (3.207)	0.410 (3.161)	0.410 (3.685)	0.517 (5.234)	0.492 (4.310)	0.295 (3.130)	0.402 (3.167)	0.816 (4.937)	0.3815 (4.173)	0.414 (2.270)	0.478 (2.885)	0.435 (2.093)	0.564 (3.610)
Constant	1.109 (4.258)	0.290 (1.335)	-2.743 (-3.336)	0.478 (1.098)	1.121 (2.328)	0.713 (2.096)	0.420 (1.846)	1.122 (2.791)	1.255 (2.258)	1.445 (3.615)	0.403 (1.001)	0.349 (2.855)	0.593 (0.663)	1.603 (2.808)
R^2- adjusted	0.833	0.899	0.933	0.971	0.960	0.882	0.908	0.969	0.925	0.917	0.949	0.969	0.897	0.892
F- statistics for testing CRS	9.945	4.993	10.890	2.247	4.589	8.604	1.505	0.5747	7.0244	3.7906	4.288	9.714	4.060	3.092

Note: (1) t-ratios are in parenthesis. Number of observations for each indusry is 60.

Chapter 6

How Spillovers Differ between State- and Collectively-Owned Firms

Technology is not easily transferable across countries and firms. The reason is that technology is rooted in skills, capabilities and knowledge which require resources and time to accumulate (Archibugi and Michie 1995). As Griliches (1994, p. 16) wrote

> 'Knowledge is not like a store of ore sitting there waiting to be mined..., it takes effort and resources to access, retrieve, and adapt it to one's own use.'

This suggests that foreign direct investment (FDI) may only be a potential source of technology spillovers, and FDI inflow itself may not always be sufficient to ensure that spillovers actually take place. In determining the effect of FDI inflow on their TFP growth, domestic firms have a important role to play. To understand the impact of FDI on domestic firms' production, domestic firms' behaviour has to be taken into account.

To study these issues in the case of China, it is necessary to examine how spillovers are affected by the special situation of the Chinese economy. The most striking feature of the Chinese economy is the coexistence of large numbers of state-owned enterprises (SOEs) and non-state owned enterprises. Firms in these two categories exhibit substantial differences in performance and behaviour. How do these domestic firms' ownership structures affect the spillover effect from FDI? This question merits thorough empirical treatment.

The purpose of this chapter is to examine how spillovers differ between state-owned firms (SOEs) and collectively owned firms in China. An understanding of these differences will shed some light on the mechanism through which technological information leaks out to domestic firms. The chapter will be organised as follows: Section 6.1 will outline the state and collective sectors in China, section 6.2 will analyse the technological behaviour of state and collectively owned firms in China, section 6.3 will present the hypothesis of the chapter, section 6.4 will provide a description of the methodology, section 6.5 will present the empirical results, and section 6.6 will conclude the chapter.

6.1 State- and Collectively Owned Sectors in China

6.1.1 State-Owned Enterprises Reform and the Remaining Problems

Since 1978, China has introduced a wide range of economic reforms. State-owned enterprise (SOE) reform has been at the core of economic reform. The major line pursued in state-owned enterprise reform has been decentralisation of decision making powers from government to enterprises. Since the initiation of the reform, state-owned enterprises were increasingly given more control over planning, production and the management of production factors.

The state-owned enterprise reform package consisted of four stages. The first was the introduction of a 'profit retention' scheme. This scheme was implemented from 1978 to 1982. It consisted of tentative steps designed to improve the performance of SOEs within a framework dominated by mandatory output planning and administrative allocation of input and products. SOEs gained the right to retain a share of total profit, and obtained control over sales of output beyond the mandatory plan. The second stage was from 1983 to 1985, when a tax-for-profit scheme was introduced. This allowed enterprises to keep all of their profits after paying state taxes, with enterprises, in principle, being responsible for their own losses. At the same time, bank loans began to replace budgetary appropriations as the chief source of external funding for enterprises. Enterprise reform entered its third stage at the end of 1986. This stage was marked by the introduction of a contract management responsibility system. This system was intended to institutionalise the enterprises' autonomy and the relationship between enterprises and the state. The basic element of this relationship was that the contribution made by enterprises to the state would be fixed according to the level of profit in the previous year (Knell and Yang 1992; Zhao 1994).

Price reform was closely linked to the enterprises reform program. This was carried out through the incremental implementation of a dual price system. Under this system, firms sell planned amounts of output at the planned price and then sell any above-plan production at market prices. By the early 1990s, nearly 70 percent of all consumer goods, in terms of sales value had been deregulated and price controls lifted from all but 111 intermediate goods (The World Bank 1993). Liberalisation of the few residual controlled prices, mainly for energy and infrastructure services, started in 1995.

China's share holding system represents a new move in the continuous effort for SOE reform. The program was implemented in 1992 and aimed to clarify the property rights of SOEs and to adopt 'modern corporate systems'. Although 8,200 SOEs had become joint stock companies by the end of 1996, they still constitute a minor percentage of total SOEs.

These reforms were intended to vitalise China's state-owned enterprises. But, despite nearly two decades of reform effort, they are still struggling to survive. As described in Chapter 5, the available estimates of annual TFP growth of SOEs in most studies are lower than that for collectively-owned firms. The reforms have been even less successful in improving the financial performance of SOEs. Profit rates have been falling since the reforms began, with one third of SOEs were still making losses in 1995 (Huang 1996).

Empirical studies have confirmed the ineffectiveness of the reform measures. Huang and Duncan (1996) conclude that the contribution of the reform measures to output growth has been negligible. Using 1986 data for 75 large and medium sized SOEs in the Chinese state industry, Lee (1990) found that no single reform measure had a significant effect on enterprise output. The size of the overall reform effect has also been small. Liu and Liu, (1996) found no evidence that greater autonomy in output decisions has been effective in promoting technical efficiency.

Many economists argue that the reason for this situation is that the behaviour of Chinese state enterprises still deviates from that of 'orthodox enterprises' (Ishihara 1990). Here 'orthodox enterprises' means enterprises which, in pursuit of profit maximisation, actively promote R&D, make investments, extend marketing, achieve technological progress, increase productivity, and accumulate profits.

It is generally agreed that the fundamental reason behind SOE behaviour is their public ownership. In the 1990s, SOEs find themselves half way between a command and a market system. With the reform, property rights relations between the state and the enterprises, in terms both of income and control rights, remained ambiguous. SOEs continue to belong to the 'whole people', which, according to Perkins (1994b) means belonging to no people.

Even the newly created share holding firms still suffer from property rights problems, due to various economic and ideological constraints. Stocks of the share holding companies consist of state shares, enterprise shares, and individual shares. The government generally holds a majority of the stock in the SOE shares. State shares are owned by the state, and managed by the 'state asset management bureau'. There is no personalised holder of state shares. The concept of the 'enterprises share' also remains controversial.

Another problem related to public ownership is the soft budget constraint. The essential feature of the soft budget constraint is the negotiability of rules, contracts and grants (Knell and Yang 1992). Despite the reform efforts, SOEs continued to negotiate loans and taxes until 1995, when a new tax policy provided a uniform set of taxes for all enterprises. In the profit retention system, the rate of profit retention was often set arbitrarily, leaving substantial room for bargaining between enterprise managers and local and central government agents. The tax-for-profit scheme was implicitly intended to harden enterprises' budget constraints, but an enterprise specific adjustment tax was imposed that made the marginal tax rate arbitrary. Under the contract management responsibility system, the tax on marginal profit was also determined by negotiation between government and the enterprises (Zhao 1994). While SOEs have increasingly been required to seek bank loans for investment, the banks have faced political and economic pressure to disperse loans to loss making SOEs. Official interference in credit decisions, weak control over lending, and insufficient sanctions against insolvent enterprises, perpetuates the accumulation of bad debts by major banks. At the end of 1994, indebtedness amongst enterprises had risen to 400 billion Yuan (approximately US$ 50 billion).

The consequence of a soft budget constraint is that enterprises can avoid bankruptcy indefinitely (Kornai 1980). Although China has had a bankruptcy law since the late

1980s, there were almost no bankruptcies of large firms until the early 1990s. By 1994, only 52 SOEs had been declared bankrupt.

There is no doubt that public ownership and soft budget constraints have contributed to the inertial behaviour of SOEs. However, while accusing SOEs of lacking incentive and work effort, most studies have tended to ignore the structural inability of SOEs to pursue such commitments. This inability lies in the dilemma between employment and efficiency faced by SOEs.

As a result of the socialist economic system combined with China's huge population, SOEs are commonly over-staffed. However, due to the complexity of the ownership structure in China, and the political sensitivity of the issue, reform of the labour market has not been as successful as it has been in the goods market.

In the area of law and regulation, SOEs have been granted autonomy for employment decisions. However, given the absence of unemployment insurance and a social welfare system for those losing jobs, SOEs cannot easily lay off redundant workers because of concerns about social stability. Official statistics suggest an unemployment rate of 2.9 percent in urban areas in 1995. However, the Ministry of Labour estimates that 15 percent, and 16.8 million of SOE employees could be made redundant with little or no impact on value or output (Huang 1996). SOEs have to take on these social responsibilities because the government is fearful of the possible social consequences of large unemployment. Many workers are employed but have little work to do. For the enterprise, labour is virtually a fixed cost. This adds to production costs and affects access to raw materials and markets.

Both before the reforms and into the early 1990s, SOEs assumed social responsibilities for lifetime employees, including providing housing, health services, and pensions, as well as providing income to their employees. Getting rid of surplus workers in SOEs, however desirable from an efficiency point of view, also means depriving redundant workers of housing and health care. By the early 1990s, privatisation and marketlization of housing was underway but is still not functioning effectively (Perkins 1994a).

SOEs have been bearing heavier costs in other aspects too. For example, before the introduction of the new tax system in 1994, SOEs paid 55 percent income tax, while collective firms paid a more flexible income tax, FDI firms paid 33 percent on income tax, and FDI firms in special economic zones paid 15 percent.

Thus, while the SOEs are protected from becoming bankrupt, they are unable to adjust their action based on profit maximisation objectives and are therefore struggling to compete with non-state enterprises. Because of these heavy social responsibilities SOEs are trapped in a vicious cycle, where high costs causes low competitiveness, which, in turn, makes it difficult to cut costs.

SOEs remain a problem for the Chinese economy and reform is difficult because, unlike the case with agriculture and services, it involves major changes of the whole economy. Perkins (1994b) suggests that the external environment in which SOEs are involved, such as financial and social welfare systems, must be changed to allow effective reform of SOEs. The dichotomy of state/non-state dualism of the Chinese economy suggests that economists tended to understate the difficulties of SOE reform during the transitional process. Entrepreneurial behaviour by SOEs will only be induced by the presence of appropriately designed economic and social institutions.

6.1.2 The Expansion of Collective Firms

Besides reforming the state-owned sector, another line followed by the Chinese government was the introduction of a market mechanism. The measures taken were intended to encourage the formation of markets for production materials, capital goods, finance, and labour (Ishihara 1990). Following this line, the tight controls on the entry of non-state owned enterprises were greatly relaxed. This led to a sustained boom in non-state enterprises throughout China. Non-state owned enterprises have increased markedly in both size and number in both urban and rural areas. From 1992, the output of non-state owned enterprise have accounted for more than 50 percent of the total industrial output (Table 6.1).

The state sector consists of enterprises owned by central and provincial government, and controlled by their industrial ministries. The non-state owned sector includes collectives firms, foreign invested firms, private enterprises, and share holding firms.

Among the non-state sector, collective enterprises constituted about 60 percent of total output in 1995. Collective enterprises include both urban collectives and township and village enterprises (TVEs). These firms, TVEs in particular, are different from SOEs in three aspects. First, they have much greater autonomy in decision making. Second, they tend to have a hard budget constraint. Third, they basically operate in accordance with market forces. Generally, urban collective firms behave more like SOEs than do TVEs. However, the data available precludes the study from separating the collective sector into more detailed categories. Nonetheless, because TVEs and urban collectives can be similar, they can be treated as one category. The statistical results should be interpreted with this shortcoming in mind.

Table 6.1. Percentage of industrial output by ownership

Year	State	Collective	Private and Other
1980	76.0	23.5	0.5
1981	74.8	24.6	0.6
1982	74.4	24.8	0.7
1983	73.4	25.7	0.9
1984	69.1	29.7	1.2
1985	64.9	32.1	3.1
1986	62.3	33.5	4.2
1987	59.7	34.6	5.7
1988	56.8	36.2	7.1
1989	56.1	35.7	8.3
1990	54.5	35.7	9.8
1991	52.9	35.7	11.4
1992	48.1	38.0	13.9
1993	43.1	38.4	18.5
1994	34.1	40.9	25.1
1995	34.0	36.6	29.3

Sources: China Statistical Yearbook, 1996

Collective enterprises, especially TVEs, responded swiftly to the economic liberalisation. An econometric study, based on panel data from more than 400 TVEs and private firms over sixteen years, showed that 'private ownership and community ownership appears to have similar effects on productivity' (Svejnar 1990). Pitt and Putterman (1992) investigated 200 TVEs and private firms in ten provinces from 1984 to 1989 and obtained a similar result. In order to understand the success of the collective sector, especially the TVEs, careful analysis is necessary of the ownership structure, budget constraints, and the basic behaviour of firms in this sector.

Collective firms do not have well defined property right structures. According to official definitions, TVEs and urban collective firms are 'collectively owned' by local communities. That is, all residents in the community establish the enterprise and jointly hold ownership over the property. However, there is a deep involvement by local government in its operation ranging from management of assets to distribution of income (Weitzman and Xu 1994).

It is generally agreed that the ownership structure of collective firms is a response to China's special economic and political situation (Chang and Wang 1994; Li 1996). The Chinese economic regulatory system still discriminates against the expansion of privately owned firms. Under the existing system of highly concentrated political powers, private firms may find it difficult to obtain key resources. Business transactions can be blocked by government agencies. Many firms registered as collectives just to gain local government support.

A widely held belief in economics is that institutions of clearly defined property rights are preconditions for economic prosperity. However, the Chinese experience seems to have constituted a major contradiction to the conventional wisdom of property rights. Collective firms do not enjoy clearly defined property rights, yet the firms in this sector have so far been successful.

In explaining the reasons for the success of the collective firms, Chang and Wang (1994) emphasise the local governments' ability to provide key inputs for TVEs. However, Weitzman and Xu (1994) pointed out that while these arguments may provide a plausible explanation for the existence of the TVEs, it cannot explain the success of the collective firms. They rely on the co-operative nature of traditional Chinese culture. In the view of Weitzman and Xu (1994), this culture makes employees behave responsibly, as if they are residual claimants or owners. Thus they are willing to deal effectively with contingencies that may not be written in a formal contract.

Gordon and Li (1991) argue that the smallness of the local government is the reason behind the collective firms' success. Since the local governments controlling these firms are small, they have to take the implicit market price for factors as given. Because these firms compete with many other local jurisdictions, the resulting allocation decisions should be relatively efficient.

More convincingly, Chang and Wang (1994) argue that the mutually beneficial relationship between the local government and the workers in the collective firms provides the base for success. The residual benefits produced by the collective firms are shared between the local government and citizens. The local governments have a strong incentive to promote local economic development because TVEs pay tax to the local government. Part of this tax payment supports the local social program and infrastructure. The remainder supports the operation of the township-village government, which often covers many benefits enjoyed by the township-village officials. The local citizens benefit from the retained profit in three ways. First, their income is increased by engaging in the industrial production. Second, development of TVEs means improved job opportunities and security. Third, increased profit also means an expanded social program. This mutually beneficial arrangement provides a stable relationship.

In turn, the local government makes at least three critical contributions to the TVE. The first is a sense of security. The second is managerial input. And the third, access to outside resources such as bank loans. Therefore, when transactions in the market are costly, ambiguous property rights may be relatively efficient, and probably even more efficient than under clearly defined property rights. Nevertheless, the collective form is a compromised ownership structure for China's current economic and political situation. As the economic reforms continue to undermine the traditional political system and as China moves to a more market oriented system, the collective form is likely to continue to become a less desirable form of organisation.

Non-state owned enterprises face harder budget constraints and often suffer bankruptcy. In 1989 about one sixth, or three million, township and village enterprises went bankrupt, or were taken over by other TVEs. In contrast, nearly all loss-making SOEs were bailed out by the State. In 1990-1991, as a result of hard budget constraints, loss making TVEs accounted for only about 6 percent of all TVE, while more than half the state enterprises were making losses (Weitzman and Xu 1994).

Collective firms also have more operational autonomy. Although most urban collective units come under the formal supervision of local government, they operate largely outside the orbit of state planning and enjoy greater managerial and financial autonomy than SOEs. TVEs have even more freedom in decision making. Once a TVE has fulfilled its financial obligations to local government, the director is virtually free in managing the business. None of the ten TVEs surveyed by Wong et al (1995) indicated that the directors are under the tight control of local government. In 1994, collective and private firms cut around 2.5 million jobs. Therefore, while non-state enterprises are not protected by government subsidy and do not have privileged access to inputs and credit, they have been subjected to minimum government controls and can therefore react to market signals freely and quickly.

6.2 Technological Behaviour of the State and Collectively Owned Firms

The first important factor determining a firm's technological behaviour is its property rights structure. This is related both to how a firm reacts to the pressure it faces for technology upgrading and to the distribution of the return from technological upgrading. The second is the market structure in which the firm is operating, because competition is the driving force in stimulating technological investment. The third is autonomy to react to market signals and freedom to engage in technology development effectively. The substantial differences between SOEs and collective firms in these areas has led to significant differences of technological behaviour for firms in these two sectors.

6.2.1 Technological Behaviour of the State-Owned Enterprises

The property rights theory states that the existence of well defined property rights is a basic precondition to the proper functioning of a market system. Without well defined property rights, managers and workers tend to obtain a larger share when they make a profit and yet expect government to bail them out when they make losses.

The technological behaviour of firms is strongly influenced by the property rights structure they face. Public ownership leads to low incentives for SOEs to improve technology. A firm's commitment to improving technology is motivated by the income they can expect to extract from any technological capacity improvement. Because of the production and consumption lag involved in realising the improved products, the return to learning normally has a long time horizon. Uncertainty caused by market fluctuations also makes it hard to predict future returns from making such technological progress. As a result, SOEs have been reluctant to commit themselves to long term technology development. Instead, workers have tended to demand as much as possible and as soon as possible in wages and fringe benefits. The average monetary compensation of SOEs' industrial workers rose by 252 percent between 1980 and 1992, while nominal labour productivity rose by 231 percent over that time (Woo et al. 1994). Chen and Wang (1987) found that most of the retained profit in SOEs was used for worker's welfare and bonuses.

In his 1980 study, Kornai concluded that a soft budget constraint is a manifestation of the paternalistic rule of a socialist state. A soft budget constraint induces uncompetitive behaviour because enterprises are not financially accountable for their actions. They will stay in business even when they are producing unwanted and uncompetitive goods. There is little incentive to improve product quality and reduce costs (Knell and Yang 1992). Technological improvement is a dynamic process in which new knowledge is discovered, tested, learned and improved. This process can only be effective through intensive and active learning. Market competition will greatly facilitate this process. However, SOE managers lack the internal motivation to learn because those making losses can continue to survive on state subsidies.

According to a survey by Li and Su (1996) of medium and large sized SOEs, only 10 percent of firms felt a strong need for technology development, 20 percent felt these was a need, but were not willing to invest to obtain the technology, while 70 percent thought there was no need to obtain new technology. The SOEs had relatively advanced technology before the reform started. Large quantities of machinery and equipment were imported in an attempt to narrow the technological gap between China and the industrialised economies. However, problems of low utilisation of capital and asset neglect were common. In some industries, such as electronics, many technologies have been imported since the reform.[1] However, little has been absorbed by the firms and effectively applied in developing better products. In a study conducted to analyse SOEs' attitude to imported technology, Shi (1995) also found that firms paid little attention to the assimilation and improvement of imported technology.

The SOEs' performance in developing technology is also constrained by low capability based on high production costs. For example, in the coal mining industry, one of the most troubled sectors, SOEs are competing with small private and collective firms, which do not pay wages or provide welfare benefits to workers, but can exchange cash for coal with individual miners on a daily basis. Working conditions are poor and safety measures out of date. This makes the costs of small mining production far lower than for the large SOEs, which enable these non-state-owned operations to sell their products at very competitive prices. As a result, stock of the SOEs accumulated, peaking at 200 million tons in 1993 (Zhu 1995). Such performances by the non-state sector continue to squeeze the profits of SOEs, with many finding it difficult to survive.[2]

Poor financial performance becomes another constraint for SOEs' technological progress. The profitability of SOEs has fallen steadily over time. Their share of profit in gross output was 24 percent in 1978, and 11 percent in 1994, and by 1995, about 40 percent of SOEs were making losses. From 1978 to 1994, total losses increased from 4.2 billion Yuan to 48.3 billion Yuan. This poor financial performance has decreased the financial capability of SOEs to obtain technology. Total R&D in output was 0.5 percent in 1994, compared with an average of 2.5 to 4

[1] Since 1992, the Government has instructed SOEs to update their technology and equipment, offering financial support to many large and well-performing SOEs for this purpose.

[2] The level of debt and the number of indebted firms has gone beyond the government's capacity to subsidize them. Nevertheless, state interference still continues.

percent for developed countries. SOEs also lack autonomy for undertaking technology development. Most projects proposals need to be approved by several levels of government departments. It can take several years for large projects to be approved.

Given that directors in SOEs are appointed by government officials, entrepreneurship is conspicuously absent. As well, many researchers and engineers are moving out of SOEs, and senior staff in possession of valued human capital are disappearing. Those who are still employed in the enterprises are not playing an active role in R&D and technology development. The reason is that most employees still hold permanent positions. In cases where labour mobility is constrained, the direct link between human capital and labour productivity is broken. Human capital can only measure potential labour productivity (Meng and Kidd 1997).

Various factors have contributed to the SOEs deteriorating technological position. It is obvious that these factors are interrelated. It will be difficult to break this vicious cycle without fundamental reform of SOEs' ownership and behaviour.

6.2.2 Technological Behaviour of the Collectively Owned Firms

While managers in SOEs are burdened with responsibility for social issues, non-state firms can focus on economic objectives. Non-state firms do not have to guarantee lifetime jobs, nor do they usually provide welfare benefits such as housing and various subsidies. Non-state firms also have much greater autonomy over their own production decisions and have been able to produce at very low cost during the transitional period due to the large surplus labour force released by agricultural reform. Wages of TVE workers are lower than their marginal productivity and lower than the wages of SOE workers (Pitt and Putterman 1992). On the other hand, TVEs tend to pay their skilled employees much higher than the SOEs (Wong, Ma, and Yang 1995). The lower production cost ensures non-state firms have the financial capability for technology improvement.

Despite their low labour costs, most collective firms are small with insufficient capital input. They are unlikely to generate a significant number of innovations because they lack the large volume of production needed to make innovations profitable.

Collective enterprises generally engage in production requiring low level technology, as well as actively making use of the SOEs capital. Basic machinery and equipment are generally produced domestically or retired from SOEs. However, once TVEs become established, and are making profits, they immediately begin to upgrade technology including importing foreign equipment (Wong et al, 1995).

A successful TVE is usually started by a person or persons with exceptional ability, great foresight and a willingness to take risks. This entrepreneurship has ensured firms will pursue every possible way of improving technology.[3] Although collective firms often have a shortage of human capital, they have managed to make use of technological manpower in SOEs. SOEs often transfer technologies to TVEs at low prices.[4] Many SOE engineers and technicians provide consultation to TVEs to gain extra income. The technical manpower in SOEs has been crucial in transferring technology to TVEs. Surveys have indicated that over 90 percent of collectively owned firms cited SOEs as the principal innovators in their products (Jefferson, Rawski, and Zheng 1992).

Compared with SOEs, collective firms face hard budget constraints, because local governments are usually too small to bail them out. Collective firms, especially TVEs, aggressively pursue technology (Wong et. al. 1995). Most of the reserve funds of collective firms are reinvested, including for upgrading technology. Collective firms also actively seek technology through means such as the 'technology market.[5] Given all of these substantially different efforts by collective and state-owned firms to obtain technology, it is not at all surprising that the collective firms are rising from a poor foundation, while the SOEs are falling behind, despite their initial technological advantage.

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[3] One TVE director surveyed by Wong et al (1995), took over a loss making chemical factory with 35 workers in 1987. He carried out numerous experiments in cooperation with a research institute, and even stole technology from his SOE competitor. Eventually, he succeeded in upgrading quality, and the company became a booming export oriented business with over 600 workers in 1994, the largest of its kind in China.

[4] An example in the survey by Wong et al (1995) indicates some SOEs would provide technical assistance to TVEs in exchange for some non-monetary rewards such as frequent gifts of fish, or the privilege for some staff to enjoy free stays at the guest house of the TVE.

[5] A technology market is a site where agencies with and needing innovations trade. The venue is often provided by a local government.

6.3 Hypothesis for Testing

Theoretical analysis indicates that FDI can have a potential positive as well as a negative effect on domestic firms' TFP growth. On the one hand, FDI can benefit domestic firm's TFP growth by bringing in advanced technology which may spillover to the domestic firms. On the other hand, in an environment where domestic firms face high adjustment costs, foreign enterprises can force domestic firms to reduce their production. As a result, the TFP growth of domestic firms may drop. Which of these effects prevails largely depends on the competitiveness and learning incentive of the domestic firms. Strong incentive combined with maximum effort to gain from technology spillover and the ability to compete with FDI firms is the key to ensuring positive spillovers.

The above analysis leads to the following hypothesis relating to Chinese firms' ownership structure and the impact of FDI on domestic firms' TFP growth.

Because of SOEs' weak incentive and ability to extract technology spillovers from FDI compared with collective firms, FDI may have a positive impact on collective firms' TFP growth and a negative impact on SOEs' TFP growth in China.

6.4 Methodology

6.4.1 Structure of the Model

In this study, the term 'technology' refers to a very broad concept. As Robock (1980, p.2) defined it, technology is

> "the perishable resources comprising knowledge, skills, and the means for using and controlling factors of producing...delivering...and maintaining goods and services".

This indicates that technology includes product, process, and distribution technology, as well as management skills. The available measures of technology, such as R&D expenditure, number of skilled employees, capital intensity or labour productivity, cover only a portion of technology. Based on this definition, TFP growth will be used to proxy technology. There are three reasons. First, only this method can capture the broadness of technology. Second, an indirect indicator has to be applied, because technology is an inherently abstract concept. The intangibility of technology means that directly measuring the level or results of technological spillover effect is virtually impossible. Third, TFP growth is a practical way to measure the spillover effect because an important purpose of technological progress is to increase productivity.

The recognition of the interdependence of various aspects of market behaviour has resulted in the use of simultaneous equations rather than the single equation model. However, it is inherently difficult to demonstrate conclusively the causal relationships between factors in the system in which TFP growth and other factors interact. Although current theory dictates some guidelines, it does not provide an exhaustive list. Therefore, the specification of endogenous and exogenous variables is to some degree a matter of judgement. While econometric techniques provide some tools such as the Hausman test, they are nonetheless too weak to provide reliable results. Therefore, this study includes all the industry level variables that are deemed to be relevant in determining the behaviour of China's manufacturing sector. Drawing on the previous theoretical and empirical studies, five endogenous variables are specified, namely, TFP growth; output share of FDI firms; export intensity; import intensity; and wage. Five simultaneous equations are set with the five endogenous variables as dependent variables respectively.

Equation 1. TFP growth

TFP growth is defined as the residual in growth of value added which is not explained by change in physical inputs. A substantial literature has been developed to explain 'the residual' and to attribute it to particular sources. However, there is no generally accepted theory of what determines TFP growth. On *a priori* grounds at least five groups of factors can be identified that influence the TFP growth of an industry. The first is FDI - the main variable of interest in this study. The second is trade variables which include exports, imports, and some variables indicating trade between domestic market segments. The third is the technology factor, including R&D intensity and the human capital factor. The fourth is the physical factor intensity such as the capital labour ratio. The fifth is the market structure which is generally indicated by sellers' concentration, entry conditions, and product differentiation. The concentration ratio is not used in this study, because, firstly, data is not available, and, secondly, the Chinese market is characterised by a large number of medium to small firms. Information available on large and medium firms is therefore considered a more suitable indication of market structure. The model specification is described below, with the symbolic representation of variables in parentheses.

FDI(FDI). Based on the analysis in the last section, a positive relationship is expected between FDI and the TFP growth of collective firms, and a negative relationship is expected between FDI and the TFP growth of the SOE sector.

Export intensity (export). The hypothesis that exports accelerate growth has been widely discussed and tested. Since the 1970s, there has been strong support for the view that rapid growth of exports accelerates economic growth. On the theoretical level, there are at least two interpretations of the correlation between exports and growth. One stresses economies of scale, which argues that exports can benefit enterprises by allowing them to take advantage of market expansion (Bhagwati 1994). The other emphasised the merit of exports by allowing firms to participate in international competition (Krugman 1984). Based on the theoretical considerations, a positive relationship between TFP growth and export intensity is expected.

Import penetration (import). An increase in imports leads to greater competitive pressures. Domestic firms have to improve productivity to survive. Imports enable domestic firms to absorb technology through products incorporating foreign technology. Given that imports influence domestic firm's TFP growth in a similar way as FDI firms, a positive relationship is postulated between import intensity and the collective sector's TFP growth, and a negative relationship between imports and TFP growth in the state sector.

Domestic regional production specification (Mktspe). Domestic market segmentation indicates production specialisation in the domestic market. This fosters trade between different regions. For a similar reason as for international trade, a positive relationship is postulated between domestic production specialisation and TFP growth.

R&D (RD). R&D aims at pushing outward the production possibility frontier for a given amount of conventional inputs. The level of R&D expenditure may influence the rate of technological progress, and, thus, the growth rate of productivity. Recent theoretical models of endogenous growth emphasise that R&D expenditure contributes to long run growth (Grossman and Helpman 1990; Romer 1986). Rant (1995) using panel data for Indian manufacturing firms over the period 1975 to 1986, estimated the effect of R&D on productivity and found a positive relationship. Using data for 1,100 U.S. companies from 1957 to 1977, Griliches (1986) showed that R&D contributed positively to economic growth. By examining the comparative advantage of the Swedish industry from 1969 to 1984, Lundberg (1988) confirmed that high R&D expenditure in Sweden had improved the Swedish market position in capital intensive industry relative to other OECD countries.

Given these theoretical and empirical studies, a positive relationship between R&D and TFP growth could be expected in China. However, given that the R&D level in Chinese industries is low, and given that China is not a leading country in developing new technologies, the result may not be significant.

Human capital (HC). It is generally agreed that human capital is one of the factors that contribute to economic growth. Using instrumental variables techniques, Barro and Sala-i-Martin (1995) found that education expenditure by governments has a very strong positive effect on growth. Using a cross-section sample of 55 developing countries, Otani and Villanceeva (1990) also showed that human resources plays an import role in growth. Thus, a positive relationship between human capital and TFP growth is expected.

Capital labour ratio (KL). The results from Chapter 5 indicate that there is a tendency that TFP growth is positively related to capital labour ratio in the state sector, and negatively related to capital ratio in the collective sector. These results are used to assign the expected signs of the relationship between TFP growth and capital labour ratio in the state and collective sector.

Net entry (Nentry) and *Production differentiation (ADV).* The increase of these two variables is positively related to the degree of competition in a market. Therefore, a positive relationship is expected between TFP growth and these two variables.

Output share of large and medium firms (LMF). Firm size is related to both economies of scale and monopoly power. In China, most large and medium firms belong to the state sector and are characterised by inefficiency and monopolistic behaviour. A negative relationship is expected between this variable and TFP growth.

The above analysis leads to the following specification of the TFP growth model:

$$\begin{array}{l} TFPG = f(\,FDI,\;\; export,\; import,\; Mktspe,\; RD,\; HC,\; KL,\; Nentry,\; LMF,\; ADV,\; time) \\ \qquad\qquad (\,(+,-)\;\;(+)\;\;\;(+,-)\;\;\;\;(+)\;\;\;\;(+)\;(+)\;(+,-)\;(+)\;\;\;\;(+)\;\;(+)\;\;\;(t)\,) \end{array}$$

Equation 2. FDI firms' share in total output

Contemporary theories of the determinants of FDI are eclectic blends of industrial organisation and international trade theories. Most of these theoretical expositions are associated with location-specific factors and ownership-specific factors or proprietary assets. The decision of an enterprise to invest in a LDC is motivated by higher expected profitability compared with alternative investment possibilities. The existence of MNCs first requires some ownership-specific advantages compared with domestic rivals in the same industry. This advantage often arises from the existence of intangible assets such as patents, trademarks, consumer loyalty to brands, positive enterprise image, managerial capabilities, and R&D resources yielding technological leadership. The second requirement is some location forces to justify the dispersion of production. The location forces can be divided into cost factors and market factors. The cost factors include the cost of inputs; while the market factors include market structure, market size, growth conditions, and efficiency of local producers.

Application of the ownership-specific and location-specific approach framework is commonly used in research on determinants of FDI (Dunning 1981). Following this approach, the output share of FDI firms in total output is specified as a function of the ownership-specific factors such as, capital and technology intensity, human capital intensity, and product differentiation; and location-specific factors such as, concentration and growth condition of the industry, export intensity, import intensity, and regional market fragmentation.

R&D and product differentiation (RD, ADV). Pugel (1978) interpreted the positive influence of R&D intensity, and advertising-to-sales ratio on FDI as evidence of ownership specific intangible assets that generate advantages for MNCs over host country rivals. Using data from 1977 to 1987, Pugel found a positive effect of R&D and advertising intensity in determining Japanese FDI in the U.S. Connor (1983) found similar results for 120 U.S. manufacturing firms, using data from the 1980s.

While product differentiation has proven to be a robust statistical explanation of FDI in developed countries, mixed results have emerged for developing countries. Using Japanese MNCs' advertising to sales ratio as a proxy, Aswicahyono and Hill (1993) found no significant relationship between advertising and MNCs' share of production in Indonesian manufacturing in 1985. In their India study Lall and Mohammad (1983) could not find a significant relationship. Given the mixed results of previous studies, no attempt is made to postulate *a priori,* the direction of the relationship between product differentiation and FDI firms output share in total output in China.

Human capital (HC). A host region's labour quality is important for foreign investors' investment decision. A higher proportion of skilled workers is expected to constitute a favourable factor in attracting FDI inflow.

Capital labour ratio (KL). This variable is expected to be negatively related to FDI in China, given that MNCs invest in labour intensive industries to take advantage of China's abundant labour force.

TFP growth of domestic firms (TFPG). One relatively consistent theme from the empirical literature on determinants of FDI is the attraction of a large domestic market in the host country. The growth hypothesis postulates a positive relationship between annual changes of market size and FDI inflow. Given that TFP growth is closely related to output growth and is an indication of the vitality of the domestic market, a positive relationship is postulated between TFP growth of the domestic firms and FDI.

Export intensity (export). Export opportunity is positively related to FDI inflow. In China, Joint ventures and wholly foreign owned firms have access to all privileges, including favourable financial treatment and the autonomy to import and export freely. For a domestic firm, the rational action to facilitate export is to establish a subsidiary joint venture with a foreign partner (Naughton 1995). The nature of incentives in the dual system encourages FDI firms to export. FDI firms have accounted for a large proportion of the increase in China's exports. Therefore, a positive relationship is expected between export intensity and FDI in China.

Import (import). Some studies argue that import liberalisation, and growing imports tend to reduce FDI, as FDI and imports could be substituted for one another (Horst 1972; Jeon 1992). On the other hand Ray (1989) argue that bilateral trade and FDI may be viewed as complementary. The relationship between FDI and import penetration remains to be empirically tested.

Large and medium firms' output share (LMF). Aswicahyono and Hill (1993) argued that the state sector crowds out private sector investment in industry and deters private sector investment to the extent that private investors fear the government will bias commercial conditions to the benefit of their own companies. Given that most large and medium firms are state owned, and that the government has always intended to protect these firms, a negative relationship is expected between FDI and the output share of large and medium firms.

Regional production specialisation (Mktspe). One trade barrier that encourages FDI is transport cost. If transport costs are high it may not be profitable for the firm to export. From the host country's point of view, it can be expected that because of high transportation costs, FDI will be greater in industries regionally fragmented (Caves 1980). However, regional production specialisation also indicates some location advantage for domestic firms of a certain industry in the region, which may deter FDI in these industries because of the potentially strong competition from local firms. Thus, this study does not attempt to postulate *a priori*, the relationship between regionally segmented industries and FDI firms' output share.

Cheap labour *(wage).* The supply of cheap labour in developing countries has been recognised as an important determinant of FDI. Many survey reports confirm that FDI takes advantage of cheap labour in LCD's (Agarwal 1980). Riedel (1975) observed that relatively lower wage costs have been one of the major determinants of

FDI in Taiwan. Schnider and Fray (1985) also found a significant negative correlation between FDI inflow and wage costs in LCD's.

Time (t) is expected to be positively related to FDI.

Other determinants of FDI include factors such as political stability. However, the political variables are omitted here, because this study is based on cross industry data from one country.

The foregoing considerations lead to the following specification of the FDI firms' output share equation:

FDI= f (TFPG, R&D, HC, KL, ADV, export, import, Mktspe, LMF, wage, time)
((?) (-) (+) (-) (+) (+) (-) (?) (-) (-) (+))

The specification for the equations with export intensity, import intensity, and wage rate is presented in Table 6A.1 in the Appendix 6.2.

6.4.2 The functional form of the TFP growth equation

How the impact of policy variables on output should be included in the production function is not apparent in light of economic theory, and so must be derived empirically. There are two possibilities. One is that the policy variables might enter the production in a neutral fashion, that is, without altering the elasticity of inputs. This has generally been identified as a disembodied form of production function (Lee 1992). Alternatively, these policy variables might shift the output elasticity of inputs. Accordingly, this form has been identified as the embodied form.

Disembodied form

The disembodied form treats policy variables as physical inputs and develops an extended production function. Numerous studies (Huang and Duncan 1997; Lin 1992) have followed this method since Griliches (1963) first applied it.

For a Cobb-Douglas production function, the disembodied form with policy variables Z takes the following form:

$$(6.1) \quad Y_t = A_t K_t^{\alpha} L_t^{\beta} \exp^{\lambda t} \exp^{wZ_{ti}+e},$$

where Y is the gross output, t is time, and K and L denote capital and labour. Taking the logarithmic form, the production function becomes:

$$(6.2) \qquad LnY_t = LnA_t + \alpha\, LnK_t + \beta\, LnL_t + \lambda\, t + \omega\, Z_i + e\,.$$

Substituting from each variable of time t the corresponding variable in time *(t-1)* and utilising the Tornqvist definition of TFP growth gives

$$(6.3) \qquad TFPG = (LnY_t - LnY_{(t-1)}) - \sum_i S_i (LnX_{it} - LnX_{(it-1)}$$
$$= b + \omega (Z_{it} - Z_{it-1}) + \mu\,.$$

Some policy variables such as FDI have a long term effect on TFP growth. That is, TFP growth not only depends on the existence of this variable in time t, but also on its lagged value. In this case

$$(6.4) \qquad Z_t = \sum_{i=(t-n)}^{t} z_i\,,$$

where z is the value of Z in each time period. Accordingly,

$$(6.5) \qquad (Z_{it} - Z_{(it-1)}) = \sum_{i=(t-n)}^{t} z_i - \sum_{i=(t-n)}^{t-1} z_i = z_{it}\,.$$

Therefore, using the value of a stock variable in time t in the right hand side of the TFP growth equation, can capture some of the accumulated effect of FDI production on TFP growth. This is only true under the assumption that the coefficient of variable Z on TFP growth in year *(t-1)* is the same as in year t, as shown in equation (6.3).

The embodied form

The policy variables change the elasticity of physical inputs in the embodied form. In this case, the Cobb-Douglas production function takes the following form:

$$(6.6) \qquad Y = A_t K^{(\alpha + w_k Z)} L^{(\beta + w_l Z)} \exp^{(bt+e)}\,.$$

The logarithmic form is :

$$(6.7) \qquad LnY = LnA_t + (\alpha + \varpi_i Z) LNK + (\beta + \omega_l Z) LNL + (bt + e)\,,$$

and the corresponding TFP growth is

$$\begin{aligned}(6.8)\quad TFPG &= (LnY_t - LnY_{(t-1)}) - \sum S_i (LnX_{it} - LnX_{(it-1)}) \\ &= b + \omega_k (Z_t * LnK_t - Z_{(t-1)} * LnK_{(t-1)} \\ &\omega_l (Z_t * LnL_t - Z_{(t-1)} * LnL_{(t-1)} .\end{aligned}$$

The embodied form of TFP growth has been tested. However, the statistical results do not support this specification because the statistics such as the t-ratios are very low and the results are not robust.

6.4.3 The Identification Problem

The Order Condition for the identification of simultaneous equations states that the number of total missing variables in the equation should be greater or equal to the number of endogenous variables minus one, for the equation to be over or exactly identified. Since there is no clear theoretical guideline as to which variables should be in the equations, econometric techniques will be utilised to determine what variables should be excluded in each equation based on theoretical specifications.

6.5 Empirical investigation

6.5.1 Data

The construction of the data base was a major task of the study. The process was time consuming because the data were available only in hard copy. In addition, efforts had to be made to remove 'implausible' observations and to make some adjustments due to the inconsistency in the classification of the statistics between Chinese provinces and for different years.

This study distinguishes the differences of spillover effects between state-owned firms and collectively owned firms. The reason the collective sector was chosen as a comparison with SOEs is because there is insufficient data for other ownership sectors. Furthermore, collective firms have been growing rapidly and they have been the most important non-state owned sector. Industry level data by province from

China is used to carry out the test. This industry level data are preferred, because it is important to investigate the impact of FDI on domestic firms' productivity on an industry wide basis. There is also more variation for the FDI variable in the industry level data.

As described in chapter 5, this study uses data for 28 manufacturing industries in20 provinces. The data set covers three years, because data for the FDI variable were available only for the period 1993 to 1995 inclusively. The sample is further divided into state-owned and collective categories. There are 3,360 observations in the sample. The endogenous and exogenous variables are measured as follows:

Endogenous variables

(1). TFP growth (*TFPG*). Comparing TFP growth between SOEs, collective sectors, and FDI sector in China is one of the major exercises of this study. TFP growth was computed for SOEs, collective firms, and FDI firms in 28 manufacturing industries. A detailed discussion can be found in chapter 5.

(2). FDI variable *(FDI)*. FDI is measured by the output share of firms with foreign direct investment in total industry output. Data availability prevents further distinguishing of FDI firms with different proportions of foreign investment. However, in the legal system, both wholly owned firms and joint ventures have a presumption of managerial autonomy, and similar operating behaviour. Furthermore, for the purpose of studying the impact of firms with FDI on the productivity of firms without FDI involvement, FDI firms could be treated as one category. Data for the FDI variable are from the provincial statistical yearbook.

(3) & (4). Trade variables (*export and import*). Export intensity is measured as the ratio of export to industry output. Similarly, import penetration is measured by the import to domestic production ratio. Trade data for most industries and provinces are not readily available from the industry statistics. Data were therefore obtained from foreign trade statistics where data are available for major commodities. Export and import variables are constructed by aggregating different commodities into the industry classification according to corresponding production information. Data obtained in this way is considered to be reasonably accurate, although some

inaccuracy may occur during this process. Date for trade variables are obtained from unofficially published reports of the State Statistics Bureau.

(5). Wage (*wage*). Wage is measured by the annual real wage income. The general consumer price index was used to convert nominal wages into real wages. Wage data are taken from China Labour Statistics.

Exogenous variables.

(1). Regional production specialisation *(mktspe).* The degree of regional product specialisation of an industry is measured by the inverse of the Hirschman-Herfindahl index (HHI) of plant dispersion across the provinces. The HHI is calculated as:

HHI = $\sum_{i=1}^{n}(n_{ij} / N_j)^2$, where n_{ij} is the number of plants in province i in industry j; N_j is the total number of plants in industry j. The value of HHI is between 0 and 1, and the value of the inverse of HHI is greater than 1. It is obvious that the greater the inverse of HHI, the greater the degree of regional fragmentation in industry j. The number of firms is obtained from provincial statistical yearbooks of China.

(2). Net entry *(Nentry)* is measured by the difference between the number of firms in year t and $(t-1)$. Net entry is calculated for total, SOE, and collective sectors in each industry.

(3). The share of medium and large firms *(LMF)* are measured by the output share of medium and large firms in total output. Data are from the provincial statistical yearbooks of China.

(4). Technology intensity *(RD)* is measured by the ratio of research and development expenditure (R&D) to sales. Data for these ratios are not published in the industrial statistics. However, R&D expenditure for large and medium firms from 1990 to 1992 is found in unofficially published reports of the State Statistics Bureau. These data are used as the proxy of technology intensity in this study. There is some justification for the measurement of this variable. First, most R&D in domestic firms is carried out by medium and large firms. Second, it is reasonable to expect some time lags for R&D spending to contribute to production and three years seems commonly accepted.

Third, by introducing lags, multicollinearity between R&D and other variables might be avoided.

(5). Human capital intensity (*HC*). The measures for human capital may be divided into two groups: skill-group measures and wage-differential measures. Skill-group measures are often preferred because wage-differentials may be distorted by labour market imperfections. The ratio of engineers and technicians in total employment is used as the proxy for human capital. Given China's long term compulsory secondary school education policy, this variable may better reflect the human capital stock than other measures, such as the proportion of employees with secondary school education. The variable is measured for SOEs and collective firms from 1990 to 1992 respectively. The reason for the lag is mainly that recent statistics do not have separate data for the state and collectively owned industries. For similar reasons as the measurement of R&D intensity, there is some justification for using the lagged values. Data for the 1990 ratio were extracted from the Labour Statistical Yearbook, and data for 1991 and 1992 were obtained directly from the Statistics Bureau of China.

(6). Physical capital ratio *(KL)* is measured by the ratio of net capital stock to employment.

(7). The ratio of value added to employment *(VAW)* is measured in a similar way as capital labour ratio. Data for these variables are from the Statistical Yearbook of China, various issues.

(8). Product differentiation *(ADV)* is measured by the ratio of advertising expenditure to sales of U.S. counterpart industries because no industry level data is available in China. The use of this data set assumes that product differentiation of an industry is similar across countries.

6.5.2 Estimation techniques

There are several well-known econometric techniques which can be used to estimate a simultaneous model. These techniques fall into two main categories; 'system methods' and 'single-equation methods'. The systems methods, of which three-stage least square method (3SLS) and full information maximum likelihood (FIML) are the best known, estimate all the identified equations in a system simultaneously. The disadvantage of these methods is that they require detailed specification of the equation system and are highly sensitive to specification error. Since these methods estimate all equations simultaneously, an error in one equation or variables can be transmitted throughout the whole system, resulting in biased estimates of the coefficients of the variables in the system. Therefore, the common practice in estimating simultaneous equation systems has been to adopt a risk-averse position by resorting to single-equation methods. These methods estimate a system of simultaneous equations by estimating each identified equation separately. Single-equation methods include the instrumental variables method (IV), the reduced form method or indirect least square method (ILS), two stage least squares method (2SLS), and limited information maximum likelihood (LIML).

The 2SLS technique is used in this study. 2SLS estimates are less sensitive to the presence of multicolinearity among regressors and misspecification of the equations compared with other single-equation methods. There are two steps involved when using 2SLS to estimate simultaneous equations. Firstly, endogenous variables are regressed on all the exogenous variables of the model. The predicted values are then used to construct instruments which are highly correlated with the exogenous variables and are not correlated with the error term. Secondly, the predicted or estimated values obtained from the first stage regressions are used instead of actual values whenever an endogenous variable is included as an explanatory variable in another equation. This method can be applied to both exactly identified and over-identified models.

Dummy variables are used to capture industry specific factors. In order to increase degrees of freedom as well as to obtain a clear picture of the industry effects, the twenty eight industries are divided into nine groups by combining similar industries into one group. These groups are:

Group 1: food processing; food manufacturing; beverage manufacturing; tobacco industry.

Group 2: textile industry; garment industry; leather, fur, and related industry.

Group 3: timber processing; furniture industry.

Group 4: paper processing industry; printing industry ; educational and cultural industry.

Group 5: petroleum processing industry; chemical material industry; chemical fibre; rubber industry; plastic industry.

Group 6: non-metal industry; smelting and processing of ferrous metal; smelting and processing of non-ferrous metal; metal industry.

Group 7: ordinary machinery industry; transportation industry; special machinery industry.

Group 8: electric machinery industry; electronics and communications; instruments and meters.

Group 9: medical and pharmaceutical industry.

The dummy for group 1 is set to zero, and for other industry groups set to 1.

For similar reasons, the provinces are classified into six regions. The classification of regions is based on the official regional classification criterion of China which classifies the thirty provinces into six regions according to geographical, social, and economic factors. Correspondingly, five regional dummies rather than 19 provincial dummies are included in the model. The classifications are as follows:

Region 1: Hebei; Shanxi.

region 2: Heilongjinag.

Region3: Shanghai; Jiangsu; Zhejiang; Aihui; Fujiang; Jiangxi; Shandong.

Region 4: Henan; Guangdong; Shenzhen; Guangxi; Hainan.

Region 5; Yunnan; Sichuan; Guizhou.

Region 6, Qinhai; Shanxi.

Region 6 is set as the base of the regional dummy variables.

Since there are substantial differences in behaviour among enterprises in state and collective sectors, the comparison of the state-owned and the collectively owned sectors is done by using both intercept and slope dummies in the equations. The state sector is set as the base of the ownership dummy variable. The degrees of freedom can be increased by pooling observations in state and collective sectors. The nature of the model in this study also implies that pooled data would be more suitable, since some variables, such as FDI variables, are common for both the state and the collective sectors.

Therefore, the general form of the equations is:

$$(6.9) \quad Y = a + a_1 * Dcol + b_i * \sum_j Z_j + b_{di} * \sum_j Z_j * Dcol$$
$$+ \sum_{nind=1}^{nind=8} d_{ind} * Dind + \sum_{nreg=1}^{nreg=5} d_{reg} * Dreg \, ,$$

where *Dcol* is the dummy variable for the collective sector. the Z_js are the policy variables such as FDI, *Dind* are the industry dummy variables, *Dreg* are the regional dummies, and *nind* and *nreg* are the number of industry and regional dummies, respectively.

6.5.3 Results and Interpretations

Several variables from the model are removed on the basis of non-nested tests. The regression results for the TFP growth and FDI equations are reported in Table 6.2 and the equations for export intensity, import penetration, and wage are reported in Table 6A.1 Appendix 6.2. The definition of the variables are presented in Appendix 6.3. Overall, the estimated coefficients are consistent with the expected signs.

TFP growth

The most striking result from the TFP growth equation is that the coefficient of the FDI variable, the main variable of interest, is negative for the state sector. The coefficient is significant at the 5 percent level. The coefficient for the collective sector is positive and significant at the 5 percent level. This finding confirms the hypotheses of the study and has important policy implications. That is, the behaviour of domestic firms is important in determining the effect of FDI on domestic firms' TFP growth. While there is potential spillover from FDI which can be beneficial for domestic firms, FDI can also be a negative force for TFP growth, if the domestic firms are not competitive.

The export variable in not significant in the result. In empirical studies, the relationship between export and TFP growth has varied widely across countries. Chenery et. al (1986), Balassa (1985), and Englandor and Guraey (1994) found a positive association between TFP growth and export. Kwak (1994) found the sign of the coefficient of export on TFP growth changes in different time periods for Korea. More research needs to be done to investigate the relationship between export and TFP growth.

The coefficient of import intensity is negative and insignificant for SOEs, suggesting that increased competition from international competitors has not pushed SOEs to be more competitive. The variable for collective firms is positive and insignificant, however, the t-ratio is greater than 1, which, to a certain degree, confirms the expectation that imports have driven the collective sector to increase TFP growth and become more competitive.

The coefficient for the capital-labour ratio for SOEs is positive and significant at the 5 percent level. The coefficient for the dummy variable representing the collective sector is negative. The finding of a positive correlation between capital labour ratio and TFP growth in the state sector is plausible because many capital intensive SOEs were designed to reduce the technology gap between China and developed countries. The government has been subsidising these SOEs to invest to new capital over years. This may have induced undervalued capital input and higher observed TFP growth, as stated in Chapter 5. In contrast, the collective sector is mainly labour intensive firms aiming to take advantage of China's cheap labour with a comparative advantage in labour intensive industries. Labour intensive industries in the collective sector have experienced rapid growth since the initiation of reform.

The coefficient on the ratio of skilled labour to total employment is positive but insignificant in the SOE sector, mainly because SOEs are not fully utilising manpower. The coefficient is positive and significant for the collective sector. As mentioned in section 6.1, the collective sector is very aggressive in improving technology and skilled labour plays a significant role in technological progress.

Regional production specialisation is positively related to TFP growth for both SOE and collective sectors.

The output ratio for large and medium firms in total output is negative for the SOE sector. The large and medium firms are mainly state-owned firms that have fallen behind in recent years. The results show that the negative effect due to the ownership disadvantage is overwhelming and there is no sign of economies of scale prevailing. The effect of this variable for the collective sector is negative but insignificant, presumably because there are few large and medium firms in the collective sector.

Regression linking entry and exit with industry output growth and import penetration rate has been attempted for several countries. Tybout (1989) found that output growth is positively related to entry. Consistent with earlier studies, net entry is found to be positively related to TFP growth in both sectors in China, as expected.

The R^2-adjusted is 0.26. Given the basically cross sectional nature of the data, and the TFP growth computed from the residual of the production function displays considerable fluctuation, the R^2-adjusted is in the acceptable range. It is low in the equation for TFP growth also due to the fact that TFP growth has a lower variation.

Output share of FDI

FDI is positively related to TFP growth of collective firms. This result confirms the expectation that FDI inflow is reacting to the vitality of the domestic market and has the tendency of entering rapidly growing industries. This finding is consistent with the result of Shan, Tian, and Sun (1997), who tested the FDI-led growth hypothesis on China using Granger-no-causality testing procedure, and indicated that there is a two-way causality running between FDI and growth in China. The significant relationship between TFP growth and FDI output share illustrates the need for using a model based on simultaneous equations.

The coefficient for export intensity is positive and significant, indicating that FDI is using China as an export platform. This is also due to the fact that export oriented FDI is preferred by the Chinese government and their establishment is more easily approved.

The wage rate has a significant negative effect on FDI inflow, although the magnitude is very small. Thus, while this variable is not likely to constitute a strong negative factor in determining FDI inflow, the industries and provinces with lower labour costs can be expected to attract more foreign investment.

The result shows that the human capital variable has a positive and significant effect on FDI, indicating that as expected, the human capital factor is important in FDI production. The coefficient for R&D is negative and insignificant, which may be due either to the fact that FDI is allocated in industries where domestic firms have an inferior technological position, or to the multicollinearity between R&D and human capital measurement. The overall performance of the model does not alter much if the R&D variable is removed.

FDI is also present in regions where domestic firms are not concentrated in a specific industry, as shown by the significant and negative coefficient of *Mktspe*. This may indicate the strategy of FDI firms in allocating production in regions where they face weaker competition from domestic rivals.

The effect of large and medium firms on FDI is negative and significant, indicating large and medium firms deter the entry of FDI firm into the Chinese market, as discussed in model specification.

FDI is increasing over time as shown by the positive coefficient of time variable.

Other equations

The results from the export intensity, import intensity, and wages are basically comparable to expectations based on the theoretical and empirical studies. The results are not discussed in detail here, however, the regression results are reported in Table 6A.1 in Appendix 6.2.

Table 6.2: Estimation results for TFP growth and output share of FDI sector

Variables	Equation 1: the dependent variable is TFP growth	Equation 2: the dependent variable is output share of FDI firms
TFPG		6.4668 (1.294)
d_{col}TFPG		1.4661 (1.944)
FDI	-0.0023 (-1.974)	
d_{col}FDI	0.0057 (4.421)	
Export	0.2109e-3 (0.891)	0.2410 (6.007)
d_{col}Export	0.4489e-3 (1.421)	
Import	-0.5996e-4 (-0.293)	
d_{col}Import	0.2436e-3 (1.007)	
Wage		-0.0033 (-2.533)
KL	0.2667e-3 (1.918)	-0.0620 (-3.05)
d_{col}KL	-0.3967e-2 (-1.001)	0.1630 (2.736)
HC	0.1059e-6 (0.2013)	0.2922e-3 (3.531)
d_{col}HC	0.1666e-3 (1.677)	0.0117 (4.764)
Mktseg	0.2125e-2 (2.921)	-0.3135 (-2.931)
LMF	-0.1449e-3 (-2.722)	-0.064 (-3.128)
d_{col}LMF	0.7579e-4 (1.050)	
Nentry	0.9047e-4 (1.888)	
ADV		0.0005 (0.9821)
InterDum	-0.0062 (-0.6348)	-5.1313 (-2.940)
t		6.3840 (6.570)
Constant	-0.0556 (1.962)	3.2893 (0.7349)
R^2 ajusted	0.256	0.4450
Number of observations	2240	2240

6.6 Conclusions

This chapter distinguishes between differences in the impact of FDI on TFP growth of state-owned and collective owned firms. Panel data based on industry level information from Chinese manufacturing industries has been used to carry out the study. To overcome the causality problems of former studies, a simultaneous equation system containing five equations was constructed.

The most interesting conclusion from the econometric study is that domestic firms' behaviour is critical in determining the impact of FDI on domestic firms' TFP growth. TFP growth of collective firms is positively related to FDI, while that of state-owned firms is negatively related to FDI. By comparing the ownership structure and behaviour of state and collective firms, it is apparent that different incentives and efforts to improve technology, and different competitive behaviour between these two sectors, causes the differences in relationship between FDI and domestic firm's TFP growth. These empirical results support the theoretical discussions of Chapter 4 in which the possibility of this outcome was foreshadowed. The results have a number of implications, which are discussed below.

The most important policy to reduce the negative impact of FDI on domestic firms' TFP growth and to foster spillover effect from FDI is to create a competitive market environment. Continued reform of state-owned enterprises is the key for the state sector to benefit from FDI. SOE reform has been at the top of the government policy agenda since the early 1990s. However, for ideological and political reasons, the attempt to reform SOEs did not involve any changes to their fundamental state-owned nature.

The current priority is to introduce a modern corporate governance system to state enterprises. The government's reform efforts are focused mainly on the 1000 largest SOEs and will let go of the small and medium sized state enterprises. However, the state still holds a majority of the shares and property rights continue to be a problem. The 'corporatisation' of SOEs has not provided sufficient conditions for improved management and efficiency. Corporate governance and its effectiveness in promoting economic efficiency, is dependent upon a firm's ownership structure. As such, property rights reform in China should not proceed in isolation, but must be closely directed towards creating a clearly defined ownership structure.

Entrepreneurial behaviour by SOEs will only be induced by the presence of 'correct' economic and social institutions. Problems related to soft budget constraints, and heavy social responsibility also require great reform effort. Despite the painful process, the only way for the current struggling state firms to be able to compete effectively is to reform these fundamental problems.

Regardless of the success of the collective firms over the past twenty years, to some extent, the form of collective firms is a compromise within the current political and economic situation in China. As economic reform continues and as China moves to a more market oriented system, the collective form is likely to become a less desirable form of organisation. Therefore, emphasis should be placed on reducing high transaction costs induced by government interference, and providing conditions for collective, as well as private firms to compete fairly and effectively. All these measures can be expected to increase the capability of Chinese firms to compete with FDI firms and to benefit from spillover effect.

Appendix 6.1. The specification of export intensity, import intensity, and the wage rate equations

Equation 3. Export intensity

The neo-classical factor proportions theory attributes export performance to factor intensity and factor endowment. However, it has been recognised that theories focusing on factor intensity alone are not adequate to explain trade patterns. This has led to a switch of emphasis to firm and market specific characteristics. The theoretical and empirical studies have taken two directions. On the one hand, there has been substantial effort to extend the factor proportions theory in various ways. On the other hand, an alternative explanation is offered by the 'technology gap' or 'neo-technology' models, which suggest that competitive performance in the export market is attained by market power achieved through technological and other forms of innovation.

Efforts have been made to incorporate both factor proportions and technological factors in empirical studies. Hufbauer (1970) has tested the export performance of 24 countries in a study designed to reflect the central elements of both the neo-factor and neo-technology theories. He reached the conclusion that a number of different factors related to both theories influence the commodity composition of trade. In recent years, some firm specification factors have also been proposed as determinants of exports. To date, there is still no standard model explaining the differences in trade behaviour. Nevertheless, a range of factors have been identified as key determinants.

In the spirit of both theoretical models, this study does not assume that a single factor can explain export performance, but, rather, conjectured that a variety of factors determine it.

Capital labour ratio (KL). The orthodox factor proportions theory predicts that a labour abundant country like China will have a competitive advantage in labour-intensive commodities and will tend to export such commodities.

Human capital (HC). Having emphasised the inadequacy of the simple Heckscher-Ohlin theory to explain actual trade patterns, Baldwin (1971), and others, argued for the inclusion of human capital as a separate factor. Based on the neoclassical model, developing countries typically have scarce human capital resources. Therefore, China is expected to have a comparative advantage in exporting commodities that are relatively intensive in unskilled labour. Thus, a negative relationship is expected between human capital and export intensity. However, the neo-technology model would predict a different outcome because human capital would increase a country's capability to export. Given the contradictory predictions from the two theoretical models, no attempt has been made to postulate *a priori*, the direction of the relationship.

R&D (RD). Firms with high R&D intensity attain a high level of technological sophistication, which gives them a competitive advantage over foreign firms. Empirical studies provide mixed evidence. Using data for Israel from 1975 to 1981, Hirsch and Bijaoui (1985) confirmed that export firms tended to have higher R&D spending. However, Willmore (1992) found R&D to be insignificant on Brazil's exports. Using data from 1978 to 1980 from the 100 largest Indian engineering firms, and 45 chemical firms, Lall (1986) showed a negative relationship between R&D and export. He interpreted this finding as a result of India's R&D effort leading to the adoption of Indian conditions which do not contract technology gaps between India and world frontiers. Given the mixed results from previous studies, this study does not attempt to postulate *a priori*, the relationship between export and R&D.

Product differentiation (ADV). Recent theoretical literature has postulated a positive relationship between product differentiation and intra-industry trade flows. Empirical investigation provides some support for a positive relationship. Willmore (1992) found that advertising was positive and significant on Brazil's trade, indicating firms producing highly advertised, hence highly differentiated goods, were more likely to participate in trade. Lall (1986) found similar results for Indian engineering and chemical firms from 1978 to 1980. Therefore, a positive relationship is expected between export intensity and product differentiation.

TFP growth (TFPG) is an explanatory variable because an improvement in efficiency increases the competitiveness of a firm. A positive relationship between TFP growth and export intensity is expected.

FDI firms' output share (FDI). Most evidence shows a positive relationship between FDI and a country's exports performance. In Singapore, more than 80 percent of manufactured export since the 1970s originated from FDI firms (Yang 1993). Using firm level data for 3,764 Brazilian exporters, and 2,826 importers, in 1981, Willmore (1992) showed a positive and highly significant relationship between export and FDI.

A positive relationship is expected between export intensity and the output share of FDI firms in China. This arises for at least three reasons. First, MNCs invest in export-oriented projects in response to a developing economy's relatively low wage cost. Second, MNCs, as part of a parent company's total global network, have technological, marketing, and brand advantages in obtaining access to the world market. Third, the government in China gives special incentives, such as tax reductions, to export oriented FDI. Export oriented FDI is also more easily approved by the government for investment in China.

Large and medium firms' output share in total output (LMF). Much of the recent theoretical literature on trade flows asserts a positive relationship between economies of scale and export. The direction of the relationship between economies of scale and export intensity in China is not clear because of its developing country status. Most Chinese exports come from labour intensive industries such as garments that do not exhibit economies of scale. Given these considerations, no attempt has been made to postulate *a priori*, the direction of the relationship between firm size and exports in Chinese manufacturing.

Regional production specialisation (Mktspe). Willmore (1992) pointed out that geographic concentration is an indirect measure of the 'tradability' of the output of an industry. This variable is expected to be positively related to exports, because when products are widely traded domestically, they are expected to be traded internationally. He also found a positive and significant relationship between geographic concentration and trade in Brazil. A positive relationship is expected between regional production specialisation and export in China.

The above theoretical considerations lead to the following specification of export intensity:

$$export = f(KL, HC, R\&D, ADV, TFPG, FDI, LMF, Mktspe, t)$$
$$((-)\ (?)\ (?)\ \ (+)\ \ (+)\ \ (+)\ \ (+)\ \ (+)\ (+))$$

Equation 4. Import penetration

This variable is symmetrical with export intensity in that it reflects both the position of comparative advantage of a industry vis-a-vas its foreign competitors, and the extent to which natural and artificial barriers limit the international flow of goods. Therefore, some independent variables can be treated symmetrically.

It is expected that *physical capital intensity* will be positively related to import penetration. The influence of *human capital* and *R&D* remains ambiguous. Empirical evidence for other developing countries shows that developing countries are net importers of technology for the simple reason that they have a comparative disadvantage in technology products. However, R&D may reduce imports if it can contract the technology gap between the trading partners. Willmore (1992) found that R&D was negatively related to Brazil's trade. *Product differentiation* can impede entry by imports. *TFP growth* may reduce imports if domestic firms become more competitive. *FDI* is expected to have a positive relationship with imports in the sense that FDI firms import more inputs than domestic firms. Willmore (1992) found that FDI had a highly significant and positive effect on Brazil's imports. However, the relationship may be ambiguous because FDI firms produce import substitutes. The variables indicating the propensity to enter into international trade should again be included, with *regional product specialisation* positively related to import penetration. A negative relationship between import penetration and the *share of large and medium firms' output* might be expected if measures aimed to protect those firms deter competing imports.

The above theoretical considerations lead to the following specification of import penetration.

$$import = f(KL, HC, R\&D, ADV, TFPG, FDI, LMF, Mktspe, t)$$
$$((+)\ (?)\ \ (?)\ \ (-)\ \ (-)\ \ (?)\ \ (-)\ \ (+)\ (+))$$

Equation 5. Wage

Competitive labour market models emphasise that industry wage differences reflect the marginal product of labour. Labour productivity is therefore proposed to be positively related to wages. In China, wages were centrally fixed during the pre-reform period. However, since reform, steps have been carried out to link individuals' wages and labour productivity (Meng and Kidd 1997). Therefore, wages are expected to be positively related to *value added per worker (VAW)* in China.

Human capital theory, in turn, suggests that individuals will invest in education and training to increase their marginal product of labour and thus, their life time income. Hence, a direct relationship is observed between *human capital* and wages. Using 1983 data, Dickens and Katz (1987) found a positive relationship between human capital and plant size.

Non-competitive theories, such as efficiency wage theory, suggest variables such as product market power measures as possible determinants. Plant and firm size are postulated to be positively related to wages since within a given industry, large employers typically pay more than small ones. Oi (1983) argues that large employers hire higher quality employees to conserve management's time since better workers are easier to monitor. Others argue that large firms pay higher wages to conserve on monitoring costs and create incentives against poor performance. The proportion of workers in large plants has been found to be positively related to industry wage (Kwoka 1983). Therefore, the *output share of large and medium firms* is expected to be positively related to wages.

Capital labour ratio is expected to be positively related to wages by the insider bargaining models of efficiency wages, as workers' bargaining power increases with the increased of capital labour ratio (Dickens 1986). The links also rely on a view that capital intensive industries are likely to be more concentrated and more likely to generate monopoly rent for incumbent firms.

FDI is also expected to be positively related to wages. Casual observation suggests that the wage gap between FDI and domestic firms is large even within the same industry. One possible reason is that FDI firms hire the best workers away from their domestic competitors. The higher wages paid by FDI firms may also reflect the fact that the new technology and management brought in by these firms raises the productivity of their workers. In China higher wages are also a way to ensure employees stay in a FDI firm given the fringe benefits and security of employment offered by SOEs.

These considerations lead to the following specification of the wage function:

$$\underset{}{wage} = f(\underset{(+)}{VAW}, \underset{(+)}{HC}, \underset{(+)}{LMF}, \underset{(+)}{KL}, \underset{(+)}{FDI}, \underset{(+)}{t})$$

Appendix 6.2

Table 6A.1 Regression results for export output ratio, import output ratio and wage rate - 2SLS estimates

Variables	Equation 3: The dependent variable is export output ratio	Equation 4: The dependent variable is import output ratio	Equation 5: The dependent variable is wage
TFPG	4.8772 (1.052)	-1.436 (-0.2742)	
d_{col}TFPG	3.4161 (1.8698)	4.2646 (1.9636)	
FDI	0.1945 (6.385)	-0.1787 (-1.892)	10.572 (5.116)
KL	0.05801 (3.057)	-0.0235 (-1.104)	0.0838 (0.0432)
d_{col}KL	-0.04967 (-1.9391)	0.1495 (2.593)	10.169 (2.212)
HC	0.2235 (3.257)		0.0160 (3.449)
d_{col}HC	0.1000 (4.939)		0.3228 (2.376)
RD	0.2786e-4 (7.353)	0.6223e-5 (2.422)	
d_{col}RD			
Mktspe	0.09290 (1.9172)	0.175 (1.998)	
d_{col}Mktspe			
LMF		-0.0154 (-2.184)	4.1549 (12.250)
d_{col}LMF			
VAW			17.706 (13.100)
d_{col}WAW			1.2524 (3.702)
ADV	0.0368 (1.6455)	-0.0048 (-1.268)	
d_{col}ADV			
InterDum	1.3200 (1.090)	-1.7595 (-1.535)	
t	-1.2087 (-1.409)		30.212 (0.5238)
Constant	-2.8155 (-0.8359)	-1.4964 (0.3517)	15.526 (7.813)
R^2 ajusted	0.4728	0.3038	0.5879
Number of observations	2240	2240	2240

Appendix 6.3

Table 6A. 2 Definition of variables

TFPG	TFP growth of SOEs
d_{col}TFPG	Slope dummy variable for TFP growth of collective firms
FDI	Output share of FDI firms
d_{col}FDI	Slope dummy for the above variable when the observations belong to collective firms
Export	Export output ration
d_{col}Export	Slope dummy for the above variable when the observations belong to collective firms
Import	Import output ratio
d_{col}Import	Slope dummy for the above variable when the observations belong to collective firms
Wage	wage
d_{col}Wage	Slope dummy for the above variable when the observations belong to collective firms
KL	capital labour ratio
d_{col}KL	Slope dummy for the above variable when the observations belong to collective firms
HC	Ratio of engineers and technicians in total employment
d_{col}HC	Slope dummy for the above variable when the observations belong to collective firms
RD	Ratio of R&D spending in total output
d_{col}RD	Slope dummy for the above variable when the observations belong to collective firms
Mktspe	Domestic regional production specialisation
d_{col}Mktspe	Slope dummy for the above variable when the observations belong to collective firms
LMF	Output share of large and medium firms
d_{col}LMF	Slope dummy for the above variable when the observations belong to collective firms
Nentry	Net entry
d_{col}Nentry	Slope dummy for the above variable when the observations belong to collective firms
VAW	Value added per employee
d_{col}WAW	Slope dummy for the above variable when the observations belong to collective firms
ADV	Production differentiation
d_{col}ADV	Slope dummy for the above variable when the observations belong to collective firms
InterDum	Intercept dummy variable for collective sector
t	Time

Chapter 7

How Spillovers Differ Between Industries

Technology progress is central to the economic development process. The important role played by technology has driven both governments and private firms to pursue technological leadership. During past decades, development of high technology industries has become the focus of concern in both industrialised and developing countries. The establishment of high-technology industries has been viewed as a means to guarantee a firm's position in the evolving international division of labour as well as an effective means of overcoming employment and structural problems (Simon 1989).

Since the initiation of the reforms, the development of advanced technology has received great attention from the Chinese government. Development of high technology industries has been considered essential for China to become a modern nation. Great expectations have been placed on FDI, recognised by the government as an important channel for technology transfer, to transmit advanced technology to China. Special incentives have been granted to FDI in high technology industries in the hope that it would introduce advanced state-of-the-art technology to China.

However, as discussed in chapter 6, technology spillover from FDI is only a potential benefit and its realisation is not always achieved. Instead, technology transfer through FDI is affected by various economic and technological factors. The relative sophistication of the technology possessed by foreign firms and the technical absorptive capabilities of domestic firms are among the most important factors in determining the spillover effects.

Given that China is a country with a large pool of unskilled labour, the 'absorptive capacity' of domestic firms in the high technology industries is generally low, and it is doubtful if the policy measures to attract FDI in high technology industries have met the expected outcome of the Chinese government in terms of transferring advanced technology to Chinese firms. The resolution of these policy questions requires a thorough investigation of how the spillover effects differ between high and low technology industries. This chapter examines how the industrial distribution of FDI affects the technology spillover effect. The chapter is organised as follows: Section 7.1 discusses FDI in China and related issues. Section 7.2 analyses the relationship between the technology gap and spillover effect and further provides the hypothesis of this chapter. Section 7.3 outlines the empirical investigation of how spillovers differ between industries, and section 7.4 presents conclusions.

7.1 FDI in China and Related Issues

The high technology sector is considered by many Chinese leaders to be the most promising catalyst for future development. The government, therefore, has been adopting policies specifically designed to promote the inflow of FDI in high technology industries. Special incentives have been granted to FDI to encourage the introduction of advanced state-of-the-art technology to China. Technologically advanced projects must meet the following criteria:

- They must be in a sector that China has targeted for foreign investment;
- They must possess sophisticated technology and have production processes and equipment that are advanced in nature;
- The technology must be new and in short supply in China; and
- The venture must help China produce new products, upgrade domestic products, increase exports, or produce an import substitution.

Once granted this status, technologically advanced projects enjoy the following benefits:

- An exemption of subsidies to workers, usually paid by foreign investors to employees to cover some of the benefits workers receive from the Chinese government.
- Priority for Bank of China loans.

- Profits remitted abroad exempted from tax. This refers to exemption from a 10 percent remittance tax normally placed on profit remitted abroad by foreign investors.

- An extended reduction period for income tax. All foreign investment is granted a tax holiday in the first two profit-making years, followed by three years at a reduced rate of 50 percent of the original income tax. After these tax benefit have been exhausted, a technologically advanced project is granted an additional three years 50 of percent reduction in income tax.

- Additional tax benefits for reinvested profits. If the joint venture uses part of its profits to reinvest in a technologically advanced project, it can receive a full refund on income tax paid on the reinvested funds in previous years.

Despite the Chinese government's effort to attract investment in advanced technology industries, the great bulk of FDI into China is concentrated in small, labour intensive operations. The inflow of large amounts of FDI in labour intensive industries has been considered by the Government as disappointing (Chapter 2). Nevertheless, it has to be asked whether policies encouraging FDI in high tech industries are able to deliver the government's policy objectives of improving the overall technology level of Chinese firms. Two related questions are firstly, whether labour intensive FDI brings any technology and what is the impact of labour intensive FDI in China, and secondly, whether domestic firms will necessarily benefit from FDI in high technology industries. The following sections seek to answer these questions.

7.2 Technology Gap and Spillover Effect

7.2.1 Labour Intensive FDI in China

A commonly recognised idea developed by Hymer (1976) suggests that multinationals can compete locally with more informed domestic firms because they possess some intangible productive asset which makes them competitive in the local market. He argued that in establishing and operating plants, foreign firms necessarily have some disadvantages compared with local firms, related to ignorance of local tastes, domestic laws, institutional frameworks, business and social customs, as well as to the costs of operating from a distance, such as those involved in travelling and communication. Foreign firms also usually have to pay higher wages and salaries to both local and foreign personnel and may be discriminated against by public institutions (Agarwal 1980). Nevertheless, when a foreign firm does invest directly in a particular country, there must be some advantage which enables them to earn more than at home. This advantage basically lies in superior technological know-how, marketing and managing skills.

Foreign firms involved in China's labour intensive industries also posses some advantage over potential domestic competitors. Studies have shown that the technological level of FDI is generally higher than for domestic ones, even in labour intensive industries (Yang 1993). More importantly, they have other intangible rent-yielding advantages, such as management and marketing expertise. These assets have not been sufficiently emphasised by Chinese authorities, and are classified as 'non-productive. However, marketing and management are important skills and are in a broader sense a part of advanced technology. Studies have shown that the diffusion of managerial and marketing skills is economically as important as the transfer of product and process technologies (The World Bank 1991, p.8). In the case of China, which has been under central planning for decades, management and marketing skills are often more important than technological superiority.

Trade theory states that a country can only extract the highest returns for its factors in those industries that are consistent with its comparative advantage. The comparative advantage of a labour abundant country like China lies in labour intensive industries which generate the highest returns. To exploit this comparative advantage, China's investment policies should not discriminate against labour intensive industries which is appropriate to China's relative capital and labour endowment. The expansion of labour intensive manufacturing sectors, conforms with China's comparative advantage, and has brought great benefits in terms of export, employment, and income (Huang and Yang 1998). The technologies of firms in labour intensive industries are also easily transferred and absorbed by domestic firms, given that they generally use mature technology.

The promotion of capital intensive industries is not at all new in China. Since 1949, the government has adopted a heavy-industry-oriented development strategy and instituted a set of compatible policies in an attempt to catch up with the industrialised economies. However, this strategy failed to promote economic growth and eventually gave way to the economic reforms of the late 1970s. Economic reform brought expansion of labour intensive industries. It has been argued that, fundamentally, economic reform in China can be characterised as changes in development strategy, from a heavy-industry oriented to a comparative advantage oriented development strategy (Huang and Yang 1998).

It is true that, with the exception of Hong Kong, all the East Asian success stories have engaged in some sectoral discrimination in policy setting in the early stages of development (Mowery and Oxley 1995). Their targeting effort was not always successful. Nelson (1993) argues that international competitiveness and innovative performance built on overall strength in training scientists and engineers, and in the adoption of technology, rather than reliance on concentrated investment in 'strategic' sectors have brought fast growth in these countries. Drysdale (1997) argues that the 'massive problems facing the Japanese economy today are in no small part a legacy of inappropriate policy strategies in the past'.

For a country like China, the cost of attracting FDI in high technology industries is very high. Poor investment conditions, such as shortages in capital, energy and raw materials, poor market conditions, human capital shortages and inadequate infrastructure, constrain the production of large scale firms in capital intensive industries. In industrialised countries, firms often relocate to lower wage countries as a result of structural change. This is especially true for labour intensive industries. Relocating labour intensive production in a labour abundant country such as China is thus a natural outcome of the international division of labour. Developing countries' attempt to attract FDI in capital intensive industries often contradict the investment purpose of MNCs, and are therefore costly and ineffective.

However, to emphasise the importance of labour intensive industries does not mean China should always remain in labour intensive productions. The coastal regions have experienced rapid industrialisation and have already embarked on industrial upgrading because of the increasing scarcity of unskilled labour and the rising cost of labour intensive production. As a direct result of increased land and labour cost, labour intensive FDI is moving out of places such as Guangdong and Fujian.

Since the 1960s, the newly industrialising countries (NICs) of Taiwan, Singapore and South Korea have all sought to attract high technology industries, yet most FDI is concentrated in labour intensive industries. In 1991, these countries have increased the share in high technology products to 15 percent from 8.6 percent in 1982 (Ostry and Nelson 1995, p.6). In Hong Kong foreign investment in electronics and textiles has accounted for the largest amount of total FDI, but its relative share has decreased in recent years. On the other hand, industries including electrical products, chemical, printing and publishing have increased. Other NICs' output mix has also gradually become more capital and skill intensive. This pattern indicates that FDI in NICs first graduated from unskilled labour intensive output, before beginning to shift gradually to more technology and capital intensive industries (Galenson 1985). Labour intensive FDI in the NICs has played an important role in transferring low to medium level technology, increasing exports and promoting growth. Studies have found that TFP growth in the labour intensive sector in Korea exceeds that in the capital intensive sectors (Pack 1992). The simple equipment which was conductive to minor innovations that increased productivity were often suggested by blue collar workers. These experiences suggest developing countries should adopt a more labour-intensive FDI strategy in the early stage of development. Through learning by doing and capital accumulation, they can gradually shift to the more technology intensive industries.

7.2.2 Absorptive Capacity and Spillover Effect

The question of whether technology can diffuse from FDI in high technology industries to domestic firms is linked to the relationship between the technology gap and spillover effect. A well known hypothesis, with regard to this relationship between TFP growth and the initial level of development is the idea of 'advantages of backwardness' developed by Gerschenkron (1962), which states that the larger the backlog, the greater the rate of technology transfer. Therefore, a greater distance from the technological frontier can convey potential productivity growth advantages. In line with this, it is natural to conclude that the more advanced the technology FDI brings in, the more technology would flow to domestic firms.

The 'advantages of backwardness' consist primarily of the availability of a pool of advanced technological knowledge that has been developed in the advanced economies and is available to the laggard economies, either as free public knowledge, or as technology embodied in capital goods (Dowrick 1992). Production of technological knowledge is more costly than its imitation and duplication, so the less developed countries are in this sense, in a more favourable position than the producers of the knowledge.

However, there is a growing body of evidence from a wide range of authors, including Abramovitz (1986) and Lucas (1988), suggesting that at some point in economic development, the advantages of backwardness are outweighed by the disadvantages. The disadvantage of backwardness is that modern technologies are strongly complementary with the local capital stock, both physical and human. Physical infrastructure such as communications networks, equipment repair, facilities, and reliable power supplies are essential prerequisites. So too may be the existence of a well educated and trained labour force. The high fixed costs of providing this basic physical and human infrastructure renders the advantages of technology transfer inaccessible to the poorest economies. Therefore, extreme economic backwardness is not an advantage.

Using data for OECD countries and some selected developing countries from the 1950s to the 1980s, Heitger (1993) shows that a relatively low technology gap favours economic growth and there is a general tendency for catching-up. The pattern of the world's productivity rate, observed during the period 1950-90 also suggests the need for a modification of the Gerschenkron hypothesis. The relationship between TFP growth and initial technology levels across all countries is in fact 'hat-shaped' rather than always positively sloped. Namely, for the group of highly backward LDCs, backwardness is a disadvantage, with the rate of productivity growth tending to be lower the greater the relative technology gap. The usual interpretation for this relationship rests on the concept of 'absorptive capacity', an ability to understand an externally sourced technology and apply it internally by the domestic firms (Gomulka 1971; Lundvall 1993; Nelson 1993).

A large amount of technology is freely available, though even then 'absorptive' capacity is required, in the sense that there must be people willing to understand and apply the technology. Without a receptive indigenous social structure, even freely available and communicated knowledge remains unused. Most of the knowledge applied by firms is not easily transmitted and reproduced, but appropriate for specific applications or by specific firms (Streeten 1972).

Diffusion is the process by which the use of an innovation spreads. It is essentially an education process. Successful technology transfer means the technology is absorbed by the recipients. Thus, the flow of technology in terms of such transfer is not simply a matter of purchase of a capital good or the acquisition of its blueprint, but involves active adoption, adaptation, and change.

It has long been recognised that the time and cost involved in imitating new products has an important effect on the incentive for innovations in a market economy. These include applied research, product specification, pilot plants or prototype construction, investment in plants and equipment, and manufacturing and market starting up (Mansfield, Schwantz, and Wagner 1981). It has been shown (Teece 1977) that the time and resources required for transferring technology are largely dependent on the relative sophistication of the technology transferred and the technical absorptive capabilities of the recipient.

Teece (1977) gives a detailed discussion of these costs in his case study of twenty-six international projects involving international technology transfer. The total costs of transferring technology were found to average 19 percent of the total costs of the projects, with the percentage ranging from 2 to 59 percent. Teece found the age of the technology and the extent to which the technology was understood by the transferee were particularly important in influencing the size of the transfer costs. By analysing data on 48 product innovations, Mansfield et. al (1981) found the ratio of the imitation cost to the innovation cost was about 0.65 on average, and the ratio of imitation time to innovation time was about 0.7. Imitation cost was not small in about one seventh of cases, due to the innovator having a technological edge over its rival in the relevant field. Often this edge is due to better and more intensive technical information based on highly specialised experiences with the development and production of related products and processes. A new product is more likely to be imitated if the imitation cost is small.

Most technologies consist of codified and tacit components, and the transfer of technology requires access to the tacit components, as well as to those codified, in a blueprint, license agreement, or data package. The importance of these tacit components means that successful technology transfer often requires the transfer of people, as well as the technologies, specifications and blueprints (Teece 1977).

The comfortable assumptions that best-practice techniques diffuse quickly, and cheaply, among countries is no longer so widely held (Bell and Pavitt 1993). More and more evidence has been leading to the belief that large technology gaps may constitute a serious obstacle to spillovers.

7.2.3 Hypothesis

Technology cannot be thoroughly codified in blueprint, or embodied in capital equipment. It cannot be successfully upgraded without a systematic improvement in the technological capability of individual enterprises. This can be seen from the experience of technology imported into China. The import of technology has been increasing since the initiation of reform in 1978. However, China's low technological capability prevents absorption of the new technologies. One study of large and medium-sized projects, completed during 1980 to 1982, concluded that 'among the nine projects, six have poor economic results' (Tidrick 1990). Another study of more than thirty major turnkey projects, undertaken in the 1970s, concluded that only one third of these projects had good operational results (Tidrick 1990). Almost none of the completed plant projects met the construction schedule in the contract. Only nine of the projects reached 90 percent of projected capacity and six remained at less than 50 percent capacity. Difficulties encountered in adjusting the equipment to use domestic raw materials was one of the main problems.

Technology transfer through FDI, like technology transfer through other channels such as licensing, is a costly, time-intensive, and knowledge-intensive process. An 'absorptive capacity' is also essential for the exploitation of technologies brought in by FDI. This capacity includes a broad array of skills, reflecting the need to deal with tacit components of the transferred technology, as well as the need to modify a foreign-sourced technology for domestic application.

The technology gap between China and advanced countries in many capital intensive industries is large and the 'absorptive capacity' of domestic firms in these industries generally low. In addition, the tacit nature of advanced technology makes it more difficult to trickle down through the economy. Thus, there is a possibility that high technology FDI will tend to operate in an enclave with no technology or product linkages to other economic sectors. In this sense, technologies brought by labour intensive FDI may be more easily diffused to domestic firms.

As has been outlined in the model in chapter 4, the entry of firms with FDI can potentially reduce the TFP growth of domestic firms when they cannot effectively benefit from spillover effect. In the case of a large technology gap between a domestic and foreign firm, the advanced technology the foreign firm possesses may not only be difficult for the domestic firm to absorb, but the domestic firm may also be forced to operate below production capacity. As a result, TFP growth may decrease or remain unchanged depending on the adjustment cost the domestic firm faces.

In line with the 'absorptive capacity' hypothesis this study puts forward the following hypothesis:

FDI may promote domestic firms' TFP growth providing the technology gap between domestic firms and the MNCs is small, while a large technology gap may cause difficulties for domestic firms to benefit from spillover effect.

7.3 Empirical Investigations

7.3.1 The Classification of Industry Groups

There is no universally accepted definition of technology and technological progress. The main indicators used to define technology intensity can be grouped into two broad sets of measures. The first set uses an indicator of technological input, such as the R&D to sales ratio, or the ratio of engineers and scientific personal to total employees, as a proxy for embodied technology. This approach defines 'high-tech' industries as all those sectors characterised by a ratio higher than a given threshold value. Earlier efforts at classifying industries by technology intensity using this method were undertaken by the International Trade Administration (ITA) in the U.S. Department of Commerce. It used R&D expenditures per sales dollar, based on the U.S. Standard Industrial Classification (SIC) codes. By determining the technology intensity for each of the SIC product classifications, it established the average technology intensity for all product categories. Products with a higher technology intensity than average were considered technology intensive (Green 1996). The second approach uses more detailed product data and relies upon the evaluation of industry experts in order to determine the technological content of various products.

The usefulness of either set of measures depends upon the particular application. However, both methods suffer from several major flaws. The method of using R&D intensity as technology intensity takes objective criteria to evaluate technology, yet fails to give any essential differences between R&D intensity and high-tech industry. The second method provides a more accurate list of individual high tech products, yet relies entirely upon subjective views to compile that list.

Different methods have been applied to define technology in the research of the spillover context. For example, Kokko (1994) used three different measures of the technology gap - the capital intensities in different industries, the amount of patent fees in different industries; and the difference in labour productivity between foreign and domestic establishments. The first two measures capture the differences in 'input' in technology. The last measure, on observed differences in labour productivity between domestic and foreign firms, capture the differences in 'output' of technology. It suffers from the problem that these differences may be caused by differences in capital intensity rather than differences in technology.

To overcome the shortcomings of previous studies in defining technology, the empirical study in this chapter employs the TFP differences between domestic and FDI firms as a criterion to classify industries groups. The grouping also makes use of information such as the capital labour ratio and the nature of the industry. This classification combines both 'input' of technology, such as capital labour ratio, and 'output' of technology, such as TFP growth, and is considered to be more reliable and comprehensive than using a single measure. Since there is a positive correlation between the capital labour ratio and the gap in TFP growth between collective and FDI industries, the classification based on TFP growth differences and capital labour ratio gives a relatively consistent outcome.

Table 7.1 Differences in TFP growth between collective and FDI sectors and capital labour ratio of the collective sector

No. of industries	Name of industries	TFP growth of the collective sector	TFP growth of the FDI sector	difference of TFP growth (Collective - FDI)	1995 K/L ratio (million yuan/000 person)
1	food processing	-0.87	2.14	-3.01	41.87
2	food manufacturing	-0.33	5.37	-5.70	34.14
3	beverage manufacturing	-3.09	0.61	-3.70	46.10
4	tobacco processing	-4.96	7.82	-12.78	82.84
5	textile industry	-1.86	2.86	-4.72	27.27
6	garment and other fibre products	2.21	6.57	-4.36	19.73
7	leather, furs, down	1.11	6.92	-5.81	21.48
8	timber processing, bamboo, cane, palm fibre and straw products	9.69	7.77	1.92	23.27
9	furniture	10.04	8.08	1.96	21.13
10	paper making and paper products	2.77	3.72	-0.95	33.39
11	printing and record pressing	4.40	-0.99	5.39	24.28
12	cultural, educational, and sports articles	9.70	10.70	-1.00	25.49
13	petroleum processing and coking products	-0.84	-0.73	-0.11	109.67
14	raw chemical materials and chemical products	1.53	9.06	-7.53	42.84
15	medical and pharmaceutical	-3.95	4.78	-8.73	35.54
16	chemical fibre	-1.06	-8.64	7.58	119.44
17	rubber products	-0.51	-7.02	6.51	25.16
18	plastic products	1.11	5.46	-4.35	41.14
19	non-metal mineral	3.38	7.70	-4.32	41.89
20	smelting and processing of ferrous metals	-3.35	8.87	-12.22	62.31
21	smelting and processing of non-ferrous metals	0.77	9.44	-8.67	60.67
22	metal products	3.89	9.65	-5.76	27.87
23	ordinary machinery	1.99	4.59	-2.60	22.62
24	special purposes equipment	2.30	4.00	-1.70	21.07
25	transportation equipment	4.19	3.68	0.51	28.47
26	electric equipment and machinery	6.01	8.76	-2.75	31.18
27	electronic and telecommunications	7.34	9.97	-2.63	40.04
28	instruments, meters, cultural and office machinery	-2.48	5.86	-8.34	20.98
29	Average	1.75	4.89	-3.14	40.42

To concentrate on the industry differences, the study only employs observations from the collective sector. The gap between TFP growth and capital labour ratio is given in Table 7.1 above.

The 28 industries are classified into four groups. The first includes four industries. They are food processing, food manufacturing, beverage, and the tobacco industry. The reasons for putting these four industries into a separate group is that they are industries whose products are largely related to consumer taste. Average TFP growth for these industries in the collective sector is negative. FDI firms have higher average TFP growth compared with firms in the collective sector in all these industries. The difference of TFP growth between collective and FDI sectors for these industries except the tobacco industries are between 3 and 6 percent. The capital labour ratio for these industries are between 34 and 47. The tobacco industry in this group has a much higher than average capital labour ratio and there is a large TFP growth difference between the collective and FDI sector. The group can be named the 'food industry group'.

The second group includes eight industries commonly regarded as labour intensive industries. They are cultural, educational, and sports articles; timber processing, bamboo, cane, palm fibre and straw products; furniture manufacturing; printing and record pressing; paper-making and paper products; rubber products; garment and other fibre products, leather, furs, down. and related products. The capital labour ratio is below average for all these industries in this group. Coupled with the comparative advantage in utilising China's cheap labour, the collective sector in these industries experienced similar or even higher TFP growth levels compared with the corresponding industries in the FDI sector. These industries are named the 'low technology group'.

The third group includes seven industries. These industries are plastic products; non-metal mineral products; textiles, ordinary machinery manufacturing; special purpose machinery; electronic equipment and machinery; electronics and telecommunications. There is a higher variation in the capital labour ratio amongst these industries, ranging from 21 in the special purpose equipment to 42 in the non-metal mineral products. The TFP growth gap between industries in the collective sector and the FDI sector are generally higher than for industries in the low technology industry group. The gap ranges from -1.7 in the special purpose machinery to -4.7 in the textile industry. Most of the industries in this group belong to the light industry category and have moderate technology levels. Industries in this group are therefore named as the 'medium technology group'.

For some industries in this group, such as the electronic and telecommunication industry, there is some complication with regard to whether to classify it as 'labour intensive' or 'technology intensive'. It is one of the few major industries whose factor endowment ranking and technology level appears to shift over the stages of economic development, from labour intensive in low income countries to technology intensive in high income economies (Hill 1998). In China, this industry is still mainly labour intensive though it is experiencing rapid transition.

The fourth group includes nine industries. They are smelting and processing of ferrous metals; smelting and processing of non-ferrous metals; medical and pharmaceutical products; instruments, meters, cultural and office machinery; raw chemical materials and chemical products; metal products; petroleum processing and coking products; chemical fibre; and transportation equipment manufacturing. Most industries in this group have much higher than average capital labour ratio. The average difference of TFP growth between industries in the collective and the FDI sector is also the highest among all the groups. Industries in these group are mainly heavy industries or industries commonly considered to have a high technology requirement. Industries in this group will be named the 'high technology group'.

It is convenient to classify the technology intensity according to the industries' features. However, each industry is far from homogenous in its pattern of production and innovation. Within the same sector, technology is likely to differ between projects based on factors like the different scale and origin of the investment. The essential feature of high technology industry is its great reliance on the application of new science based technologies for products or the production process. Yet sophisticated technological innovation takes place in most industries. The 'Green Revolution' in agriculture and the new fibres in textiles, are examples of this in sectors generally considered to be low technology (Patrick 1986).

Thus, the determination of technology intensity based on industry data results in distortions arising from product heterogeneity which exists in most industries. It is therefore better to use product based features to determine technology intensities, but these data are not available. In addition, as the purpose of this study is to examine the impact of the technology gap on the spillover effect, the industry based classification would basically serve the purpose.

7.3.2 Model Specifications

The model is specified the same way as in chapter 6, with one difference that a dummy variable for each industry in each group is assigned to capture the industry specific effect, whereas in chapter 6 industry dummies were set by arranging similar industries into groups. Regional dummies are still set in the same way as in chapter 6. The observations for the collective sector are used for the test in order to concentrate on analysing how spillovers differ between industries.[1]

To investigate the effect of a technology gap on spillover effects, the sample is divided into four groups according to the criterion outlined above. The regression is run separately for each group. Based on the hypothesis of this chapter, the expectation is to find stronger signs of spillovers in the sub-samples with smaller technology gaps.

For similar reasons as those outlined in chapter 6, there could also be causalities between TFP growth, FDI, export intensity, import intensity, and wage rate. Therefore, the two stage least square technique is used to capture the simultaneous determination of the endogenous variables. Five simultaneous equations are included in the system, with the five possible endogenous variables, as the dependent variables respectively.[2]

TFP growth equation

The explanatory variables included in the equation with the TFP growth as dependent variable are described in chapter 6. Different results for some variables are expected in different industrial groups.

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[1] The measurement and source of data is described in chapter 6.
[2] See chapter 6.

FDI (FDI). Based on the analysis of the last section, a positive relationship between FDI and TFP growth in the low technology and medium technology group is expected. For the high technology group, however, a negative or insignificant relationship between FDI and TFP growth is expected. The expectation for the group of food industries is somewhat complicated. Being a group with low technology industries, it would be expected to show a positive relationship. However, the TFP growth pattern (see Chapter 5) for industries in this group presented a different picture, that is TFP growth of all industries are negative and below those of the corresponding industries in the FDI sector. Therefore, no attempt is made to postulate *a priori*, the direction of the relationship between TFP growth and FDI for industries in the food industry group.

Import penetration (import). Given that imports affect TFP growth of domestic firms in a similar way to FDI, a positive relationship is postulated between import intensity and TFP growth in the low and medium technology group, with a negative relationship between import intensity and TFP growth in the high technology group. For the food industry group, it is intended to find the direction of the relationship by empirical tests.

For similar reasons as those described in chapter 6, a positive relationship is expected between TFP growth and *export intensity*, *human capital, R&D intensity*, and *net entry*. A negative relationship between TFP growth and *capital labour ratio* is expected.

A positive relationship between TFP growth and *domestic market specialisation* and a negative relationship between *output share of large and medium firms* and TFP growth is expected for industries in the medium and high technology group. However, no attempt is made to postulate *a priori,* the direction of the relationship between TFP growth and *domestic market specialisation* and *output share of large and medium firms* in the food industry group, and low technology group, given that industries in these groups are characterised by small scale production scattered all over the country.

The signs for the variables in the TFP growth equation are summarised in Table 7.2. below. As in chapter 6, econometric techniques are utilised to determine what variables should be excluded in each equation based on theoretical specifications, since there is no clear theoretical guideline about the inclusion of the exact variables in the equations.

Table 7.2 The expected result for the TFP growth equation: The dependent variable is TFP growth in the collective sector

Variables	Food industries group 1	Low technology group	Medium technology group	High technology group
FDI	?	+	+	- or insignificant
Export	+	+	+	+
Import	?	+	+	- or insignificant
KL	-	-	-	-
HC	+	+	+	+
RD	+	+	+	+
Mktspe	?	?	+	+
LMF	?	?	-	-
Nentry	+	+	+	+
ADV	+	+	+	+
t	+	+	+	+

No obvious difference for variables included in other equations are expected. The model specification and expected signs of variables are presented in Table 7.3 below.[3]

Table 7.3 The expected result for the equations of FDI, export intensive, import intensity, and wage rate

Variables	Equation 2: the dependent variable is output ratio of firms with FDI	Equation 3: the dependent variable is export output ratio	Equation 4: the dependent variable is import output ratio	Equation 5: the dependent variable is wage
TFPG	?	+	+	
FDI		+	?	+
Export	+			
Import	-			
Wage	-			
KL	-	-	+	+
HC	+	?	?	+
RD	-	?	?	
Mktspe	?	+	+	
LMF	-	+	-	+
VAW				+
ADV	+	+	-	
t	+	+	+	+

[3] See chapter 6 for model specifications.

7.3.3 Results and Interpretation

TFP growth

The regression results for the equation with TFP growth as the dependent variable are reported in Table 7.4.

Table 7.4. The estimated result for the TFP growth equation: The dependent variable is TFP growth in the collective sector

Variables	Food industry group	Low technology group	medium technology group	High technology group
FDI	0.0026 (1.163)	0.0039 (2.917)	0.0013 (1.961)	-0.0007 (-0.030)
Export	0.0031 (0.475)	0.0035 (1.9286)	0.0024 (1.9287)	0.0040 (0.698)
Import	0.0042 (0.188)	0.0072 (1.9977)	0.0056 (1.9927)	0.0014 (0.528)
KL	-0.0103 (-2.434)	-0.0073 (-1.113)	-0.0094 (-2.105)	-0.0094 (-2.206)
HC	0.0666 (1.108)	0.0218 (1.806)	0.0237 (1.9479)	0.026 (1.9043)
Mktspe	0.0015 (0.1032)	0.0156 (2.544)	0.01778 (3.861)	0.0208 (3.150)
LMF	-0.0007 (-1.138)	-0.0005 (-1.659)	-0.00003 (-0.0542)	-0.0006 (-1.362)
Nentry	0.0032 (0.8409)	0.0018 (1.7829)	0.0047 (3.278)	0.0042 (0.9541)
Constant	0.12224 (0.3138)	0.0049 (0.0281)	0.0758 (0.4706)	-0.3522 (-1.579)
R^2 adjusted	0.2915	0.3154	0.2827	0.2435
Number of industries	4	8	7	9
Number of observations	160	320	280	360

The regression reveals that the relationship between TFP growth and output share of FDI is different in different industry groups. The result is positive and significant at a 1 percent level in the low technology group. The relationship is also positive and significant in the medium technology group. The result is negative, and not significantly different from zero, for industries in the high technology group. The magnitude of coefficient for this variable also varies amongst different groups, with the coefficient in the low technology group having the highest value, followed by the medium technology group, and the food industry group, and a value close to zero for the high technology group. The significance of these result need to be stressed. They mean that large technology gaps prevent technology spillovers from happening.

The relationship between FDI and TFP growth in the food industry group is positive and insignificant, indicating there is no strong relationship between FDI and TFP growth in these industries. This may be because industries in this group are largely dependent on consumer taste and loyalties. However, the t-ratio for the variable is greater than 1 in this group which shows there is a tendency for a positive impact of FDI upon the TFP growth of these industries.

Comparing the result for the different technology groups, it appears there is a negative relationship between the technology gap and the spillover effect. This finding confirms the hypothesis in this chapter about the relationship between spillovers and technology gaps between domestic and foreign firms. It indicates that a low to moderate technology gap between foreign and domestic firms accelerates spillovers, while a large technology gap between foreign and domestic firms impedes spillovers. This is consistent with some previous research such as that of Cantwell (1989), which state that only when the domestic firms' technological capability is not greatly lower than that of the foreign counterpart, can they benefit from the spillover effect.

Export intensity. The coefficient for export is positive and significant in low and medium industry groups. However, the result is not significant in the food industry group and the high technology group. This should be expected because most export industries in the collective sector are concentrated in the low technology and medium technology groups.

Import intensity. The coefficient of import intensity varies across different industry groups. The results are positive and significant for industries in the low and medium technology group, and insignificant for industries in the food industry group and high technology group. The interpretation of these results is similar to the relationship between FDI and TFP growth, given that import affects domestic firms' TFP growth in a similar manner to FDI.

Capital labour ratio is negatively related to TFP growth in all four industry groups. This finding is consistent with the fact that the collective sector is developed by taking advantage of China's cheap labour supply and has shown a high level of competitiveness in labour intensive industries.

Human capital is positively related to TFP growth in all the groups. The result, however, is not significantly different from zero in the food industry. This may be due to the fact that industries in this group use traditional production procedures and human capital s not playing an important role in the production process.

Regional production specialisation is positively related to TFP growth and highly significant in the low, medium, and high technology groups. The result is insignificant in food industry group, presumably because production for products such as food and beverages are localised and the regional trade for these products is limited relative to other manufacturing industries.

The output ratio for large and medium firms is not significant in all industries. This is mainly because most of the large industries are state owned. However, the signs for this variable are negative in all industry groups. The state-owned large and medium firms have been protected by the government. The existence of these firms tend to cause difficulties for non-state owned firms in getting access to resources and markets.

Consistent with the expectations and former studies, *net entry* is found to be positively related to TFP growth in all groups.

Time does not significantly affect TFP growth in all groups, due perhaps to the short time period covered by the sample. The variable is therefore deleted.

Output share of FDI

The result for output share of FDI as the dependent variable is presented in Table 7.5.

Table 7.5 The estimated result for FDI equation: the dependent variable is output ratio of firms with FDI in total output

Variables	Food industry group	Low technology group	Medium technology group	High technology group
TFPG	3.360 (1.334)	7.5896 (2.654)	2.8858 (1.9920)	0.3059 (0.5707)
Export	0.5041 (2.086)	0.1706 (2.701)	0.1263 (2.408)	0.2951 (4.629)
Import	-0.4298 (-0.7809)	0.0745 (0.6582)	-0.0766 (-1.900)	-0.0236 (-0.8096)
KL	0.2713 (2.319)	0.5582 (2.130)	-0.1642 (-1.142)	-0.1395 (-1.574)
HC	3.1292 (1.056)	3.7118 (2.003)	3.2263 (2.140)	0.6452 (3.557)
LMF	-0.0340 (-0.525)	-0.0524 (-0.810)	-0.1083 (-1.916)	-0.1471 (-2.184)
Wage	-0.0022 (-1.609)	-0.0040 (-5.109)	-0.0147 (-6.374)	-0.0076 (-7.830)
t	4.525 1.680	7.1212 (3.375)	5.2667 (2.682)	3.7099 2.006
Constant	-11.968 (-0.8376)	-24.762 (-3.786)	-9.0299 (-0.8625)	
R^2 adjusted	0.3611	0.4107	0.4782	0.5068
Number of industries	4	8	7	9
Number of observations	160	320	280	360

TFP growth. The result shows that TFP growth is positively related to FDI in the food, low, and medium technology groups. This finding indicates that FDI is allocating production in the faster growing domestic industries. However, the relationship between FDI and TFP growth in the group with high technology industries is insignificant. The reason may be because firms in the collective sector in this group are not well developed and have not shown vitality in the domestic market.

Export intensity. The relationship between export intensity and output share of FDI is positive and highly significant for two reasons. Firstly, FDI is using China as an export platform. Secondly, there are government policies which explicitly require and attract FDI engaging in exporting products to international markets.

Import penetration. The coefficient for import penetration is insignificant in the food industry group, low technology group, and high technology group, indicating that imports are not an important factor in determining FDI inflow. However, the relationship is negative and significant in the medium technology group. This result may be induced by the fact that FDI in industries in this group produce import substitutes for the domestic market, such as the electronics industry, so that a large amount of imports reduce FDI inflow. This is consistent with the findings in some studies which argue that import liberalisation and a continuous growing imports tend to reduce FDI, as FDI and imports could be substituted for one another (Jeon 1992).

Wage is negatively related to FDI inflow in China, which confirms that China's low labour cost is an important factor in attracting FDI.

Capital labour ratio. Given that China is a country with a comparative advantage in labour intensive industries, the expected relationship between the capital labour ratio and FDI is negative. This expectation is confirmed in the medium and high technology groups. However, the result is positive and significant in the food and low groups. This may be because that collective firms are disadvantaged and discriminated against in getting access to capital in China. Therefore, the corresponding capital labour ratio in collective firms is below the optimal level. This is especially true for firms in labour intensive industries, because it is extremely difficult for them to obtain loans from the state-owned banking sector.

FDI is positively correlated to the *human capital* variable in all groups, suggesting that the human capital factor is important in FDI production.

The effect of *large and medium firms* to FDI is negative and insignificant in food and low technology groups, but negative and significant in medium and high technology groups. Most large and medium firms are state-owned and concentrated in industries with medium to high technology levels. The Chinese government has always intended to protect these large and medium firms. This protection may have deterred the entry of some FDI firms into the Chinese market.

The rapid increase of FDI inflow in China is confirmed by the positive and significant coefficient of *time* variable.

Other equations

The results for export intensity, import intensity, and wages as the dependent variables are reported in Table 7A.1 7A.2, and 7A.3, respectively, in Appendix 7.1. The results are generally consistent with the theoretical predictions. The two way causality among the endogenous variables are confirmed by the results, which further justifies the need to employ simultaneous equations.

7.4 Conclusions

A well known hypothesis, with regard to the phenomena of convergence in the post-war period, is that the advanced economies could bring into the backward countries a large backlog of unexploited technology which already had been in use (Heitger 1993). Thus, the developing countries will be able to exploit technological advances pioneered by the technology leaders since the adoption of new technology is assumed to be less costly than its discovery and development. Therefore, the developing countries have the potential to make great leaps forward in economic development than the technological leader, and thus have the potential for catching up. In addition, it is also assumed that the larger the technological gap, the stronger is the follower's potential for catching up.

Seeking to benefit from this 'advantage of backwardness' is one of the important motivations for governments in many developing countries to attract FDI in high technology industries. However, there is growing evidence to show that the idea of 'advantage of backwardness' needs some qualifications. The highest rate of technological adoption has not been achieved by the least developed countries but by the moderately advanced ones.

Despite international experience which indicates that technology is not easily transferred from a foreign source to domestic firms, the Chinese government has been making a special effort to attract FDI in high technology industries. Have these policy measures fulfilled the expectation of the government in terms of improving domestic firms' technology levels? Answers to this question merit a thorough empirical investigation.

This chapter attempts to determine the relationship between the spillover effects from FDI and the technology gap between domestic firms and foreign firms in China. The test has been conducted by dividing observations in 28 manufacturing industries into four groups, according to the observed gap in TFP growth and the capital labour ratio between the foreign and Chinese firms, from 1993 to 1995. Results from the regression show that spillovers are positive and significant in industries which are mainly labour intensive and have a low to moderate technology gap between the Chinese and foreign firms. However, in the industries with a high technology gap and a high capital labour ratio, the spillover effect appears to be insignificant. Overall, the results present a negative relationship between spillovers and a technology gap with foreign firms.

These findings suggest that measures aimed at promoting FDI in high technology industries may not be sufficient to generate spillovers. Technology cannot be absorbed by local firms when the technological gap between them and the foreign partners is large. Therefore, attracting FDI in high technology industries will not deliver the government's expected outcome, in terms of diffusing high technologies to domestic firms.

China's success during the reform period has been mainly attributable to market-oriented reform, which led to less discrimination against the labour intensive sectors. Simple technologies and more labour intensive sectors allow an increase in domestic productivity and the exploitation of non-proprietary knowledge that is more readily available in these sectors at the early stage of development. Technologies brought in by FDI are not easily diffused when the technological distance between the local and foreign firms is great. Therefore, special treatment for FDI in high technology industries, and discriminations against labour intensive sectors may not only be costly and ineffective in promoting technology development in China, but it could also delay the process of 'labour-intensive' industrialisation.

The other message from the empirical study is that the acquisition of foreign technology is not a short term operation, but rather it is a complicated and dynamic process. Technological capability is crucial for adapting technology to local circumstances and diffusing it through the economy. One important element in a country's ability to make effective use of advanced technology is an adequate technology and human capital base. Intensive effort will have to be made to improve China's absorptive capability. The accumulation of human capital, physical capital, and mastery of technological skills by local firms are all necessary prerequisites for spillovers to take place. This will require investment and patience. Therefore, investment in basic infrastructure, education and training, and encouraging domestic firms R&D are all necessary measures to ensure successful spillovers to take place.

International trade and investment has led to an enormous exchange of technological know-how. This study, however, delivers the message that government policy seeking advanced technology by attracting foreign investors in industries with advanced technology may not be sufficient to fulfil these expectations.

The second policy measure for domestic firms to gain TFP growth from FDI is to increase domestic technological capability. Government can play an important role by encouraging technological innovation and improving the educational level, and by investing in technology development.

Appendix 7.1 The estimated results for equations with export intensity, import intensity and wage as dependent variables

Table 7A.1 The estimated result for export intensity equation: the dependent variable is export output ratio

Variables	Food industry group	Low technology group	Medium technology group	High technology group
FDI	0.0725 (2.375)	0.1948 (2.827)	0.2401 (4.005)	0.3080 (3.139)
TFPG	1.5077 (0.5199)	2.8558 (2.2775)	3.7466 (2.2294)	3.0670 (2.594)
KL	-0.0338 (-1.098)	-0.2226 (-2.260)	-0.1390 (-2.083)	0.0159 (0.3369)
HC	-2.5187 (-1.705)	0.6245 (0.5957)	3.5214 (3.011)	0.3015 (3.653)
Mktspe	0.1610 (1.221)	1.2623 (1.866)	0.3218 (1.993)	0.2977 (2.376)
t	-2.2186 (-2.103)	-2.2588 (-1.103)	0.9416 (0.4914)	0.01062 (0.0064)
Constant	12.359 (2.934)	-4.2796 (-0.5097)	-3.3957 (-0.5841)	-8.6774 (-1.724)
R^2 adjusted	0.3824	0.4660	0.4447	0.3886
Number of industries	4	8	7	9
Number of observations	160	320	280	360

Table 72.A The estimated result for import intensity equation: The dependent variable is import output ratio

Variables	Food industry group	Low technology group	Medium technology group	High technology group
FDI	-0.0025 (-1.1953)	-0.0178 (-1.9211)	-0.0454 (-1.9139)	-0.0555 (-1.9558)
TFPG	0.1126 (0.1720)	1.4685 (1.7432)	1.5353 (1.8362)	2.8643 (1.998)
KL	0.0048 (1.2089)	0.2153 (1.521)	0.1552 (1.9865)	0.2194 (2.057)
RD	0.1526e-7 (1.130)	0.2346e-7 (1.0962)	0.3635e-6 (4.028)	0.1011e-6 (1.8379)
Mktspe	0.1021 (2.017)	0.1982 (1.170)	0.0780 (0.5268)	0.3156 (1.499)
LMF	-0.0014 (-1.473)	-0.00013 (-0.0387)	-0.0394 (-2.116)	-0.0198 (-1.828)
t	0.6699 (1.347)	0.0287 (0.0237)	0.6762 (0.2445)	-4.7991 (-1.698)
Constant	-2.4624 (-1.976)	-1.3253 -0.3382	-5.9067 (-0.7217)	12.914 (1.612)
R^2 adjusted	0.3731	0.2924	0.3810	0.3398
Number of industries	4	8	7	9
Number of observations	160	320	280	360

Table 7A.3 The estimated result for wage rate equation: the dependent variable is annual wage rate

Variables	Food industry group	Low technology group	Medium technology group	High technology group
FDI	11.188 (2.119)	13.519 (6.458)	19.463 (4.123)	24.962 (6.323)
KL	10.640 (1.010)	62.080 (5.968)	33.314 (2.488)	11.061 (2.920)
HC	5.8731 (2.039)	1.8085 (1.995)	2.0548 (3.363)	3.2655 (5.983)
LMF	0.8826 (0.4699)	3.0723 (4.472)	6.6091 (5.428)	1.6557 (1.953)
VAW	2.424 (1.8752)	5.2901 (6.866)	1.4848 (1.510)	3.2429 (4.858)
t	81.783 (0.5399)	-31.37 (-0.4530)	-51.992 (-0.5472)	26.380 (0.3772)
Constant	2227.7 (4.547)	1425.8 (6.788)	1208.7 (3.419)	2084.4 (5.426)
R^2 adjusted	0.4545	0.7643	0.6741	0.6724
Number of industries	4	8	7	9
Number of observations	160	320	280	360

Chapter 8.

Channels for Spillover Effect: Case Studies

Various studies have addressed issues related to the rapid inflow of FDI into China (Chapter 3). While these studies have recognised the general benefits that FDI has brought to the Chinese economy, detailed analyses of specific channels through which spillovers take place are scant. Virtually none of the studies go on to explore the differences in spillover patterns between firms in different ownership categories and industries.

In analysing FDI and the resulting spillover effect, much can be learnt by using econometric tools. However, the spillover process contains many intangible elements that cannot be conveyed by statistical methods alone. Evidence gathered from case studies is thus of particular interest. This chapter attempts to assess the particular channels for spillovers from FDI in China, and to analyse factors behind the various failures and achievements. This is done by examining information from a recent survey conducted by the author of selected state-owned, collectively-owned, and foreign invested firms in China. A better understanding of the essential factors involved in the spillover effect will lead to an enriched understanding of the economic development process. The remainder of this chapter will first compare the spillover channels between state- and collectively-owned firms in the context of economic reform policies. Then it will analyse differences in spillover channels between firms in high technology and low technology industries, respectively.

8.1 The Case Studies

8.1.1 Selection of the Site for the Case Studies

The case studies were conducted in Shenzhen which is the oldest and most established Special Economic Zone (SEZ)[1] in China. Before the establishment of this Special Economic Zone in 1980, Shenzhen was a small town in Baoan county, Guangdong Province, and was regarded as one of the poorest localities in the province.

The special economic zone policy was an important part of China's strategy to open up to the world. A central part of the SEZ policy is to use preferential treatment to attract FDI in order to acquire foreign capital, advanced technology, management know-how, and marketing skills. In Special Economic Zones, income tax of foreign invested firms is reduced by 20 to 50 percent, or waived from one to three years. Firms which reinvest their profit in the special zones for five years or more may apply for further reduction or exemption of income tax on the amount reinvested. Apart from cigarettes and liquor, approved imports are exempt from customs duties. Other special treatment includes land available on favourable terms, after tax profits allowed to be repatriated without penalty, reduced welfare contributions to cut labour costs, raw materials and equipment available at preferential prices based on charges to state-owned enterprises, and the decentralisation of decision making power allowed local authorities to cut through much of the old bureaucratic red tape (Murray 1994).

Because of its extensive economic and cultural connection with Hong Kong and Macao, Shenzhen was considered as a favourable site for establishing a SEZ. In August 1980, it became the first SEZ in China. By the end of 1995, some 13,200 FDI projects had been set up in Shenzhen, involving US$ 6.66 billion of utilised FDI. The annual inflow of FDI, measured by the value of actually utilised FDI, rose from US$ 5.48 million in 1979 to US$ 179.89 million in 1985, and US$ 1.31 billion in 1995.

Shenzhen benefited from the special policies rather than government capital investment. Nearly two decades after being declared as a Special Economic Zone of China, it has been transformed from a small town into a modern city. The average

[1] The four earliest established Special Economic Zones are Shenzhen, Zhuhai, Shantou, and Xiamen. Those zones are established in early 1980s to explore ways of economic reforms. All of these SEZs are located along the coastal line and close to the outside world: Shenzhen borders Hong Kong, Zhuhai is adjacent to Macao, while Xiamen and Shantou are near Taiwan.

wages of Shenzhen workers has been the highest in China. The per capita income is more than seven times the national average. By the end of 1995, GDP in Shenzhen reached 79.57 billion Yuan, with the average annual growth rate at 35.5 percent from 1979. The export value in 1995 was US$ 20.53 billion, with an average annual increase of 53.4 percent since 1979. Shenzhen has become a model to emulate, with other Chinese cities urged to catch up with the 'Shenzhen Speed' of rapid development.

Besides the long and intensive experience in utilising FDI, Shenzhen also pioneered industrial reforms such as the experiment in a share holding system. With this background, Shenzhen is an ideal place for studying the interaction between firms with foreign investment and Chinese firms.

8.1.2 The Case Studies

Case studies are necessary to convey qualitative information such as firm behaviour and channels for spillover effect. These variables are very difficult to quantify without losing some parts of their true meaning, yet they are essential for understanding the mechanism through which FDI affects the technological behaviour of domestic firms.

The technological activities of firms in different ownership categories and industries forms the focus of the case study, upon which the empirical framework of the thesis is also based. The main phenomena to be analysed are channels of spillover effects. These are measured by grouping the questions on the questionnaire for the survey into three broad categories: those that capture the nature of state-owned, collectively-owned, and foreign invested firms; those related to technological behaviour of firms in different ownership and industry categories; and those specifically targeting channels of spillovers from FDI firms to domestic firms.

As well as making comparisons between firms in different ownership categories, the sample also had to cover industries which are conventionally identified as low technology and high technology industries. The firms interviewed needed to be representative, co-operative, as well as able to provide relevant information about their operations in general and about their technological behaviour in particular.

The two basic methods available for collecting primary data are mail questionnaires and interviews. The main limitations of the mail survey method is the possible low response rate. Moreover, under this method, the researcher cannot amplify or clarify the questions and observe the respondent's answer. In view of these limitations, a direct interview approach was chosen.

The survey was conducted from October 1996 to February 1997. Due to the limited funds and time available, it was not possible to cover as large a sample as initially desired. About 36 firm managers were contacted. However, 9 interviews were not very informative. The 27 firms which provided applicable responses belong to the following categories:

Table 8.1 Firms interviewed

State-owned enterprises		Collectively owned enterprises		Foreign invested firms	
Industry	Number of firms	Industry	Number of firms	Industry	Number of firms
Electronics	4	Electronics	3	Electronics	3
Food and beverage	3	Food and beverage	2	Food and beverage	2
Petro-chemistry	1	Garment	1	Garment	4
Communication	1	Communication	1		
Machinery	1			Machinery	1
Total	10	Total	7	Total	10

8.2 Comparison between State- and Collectively Owned Firms

8.2.1 General Features of the State-Owned, Collectively Owned, and Firms with Foreign Direct Investment

Questions regarding the general operational differences between state-owned firms, collectively owned firms, and foreign invested firms were asked in order to understand their technological behaviour in a boarder perspective. A summary of the basic responses is listed in Table 8.2.

Table 8.2 General characteristics of state, collective, and foreign invested firms

Items	State-owned firms		Collectively owned firms		Foreign invested firms	
	Number of response	% in total no. of SOEs interviewed	Number of response	% in total no. of collective firms interviewed	Number of response	% in total no. of FDI firms interviewed
Top managers appointed by government	9	90	2	28	1	10
Being able to hire and fire workers	0	0	6	86	10	100
Government involvement in important decision making	8	80	1	14	0	0
Welfare responsibilities	10	100	1	14	0	0
Debt to net fixed asset ratio greater than 50%	7	70	1	14	0	0

The interviews of state-owned firms basically confirmed the problems existing in SOEs and analysed by previous studies. With few exceptions, SOEs in Special Economic Zones such as Shenzhen are commonly experiencing low efficiency and are running at losses. The major problems of SOEs are related to both internal and external factors.

The continued government involvement in firm operations is the basic problem facing most SOEs. Ninety percent of senior managers interviewed were appointed by relevant government departments. In one case, an election was held by workers to select managers. However, all the candidates are appointed by government, and important business decisions are subject to the approval of governing departments. In some cases, the approval by the government is just a formality. However, this requirement means that valuable time is wasted, and as a result opportunities are often missed.

Four SOEs interviewed are share holding companies, which is one of the government's new measures to reform state-owned enterprises. These companies are generally large and include several subsidiaries. A common feature of these share holding companies is that the government holds the majority of the shares, ranging from over 51 percent to more than 80 percent for the firms interviewed. The Shenzhen State Asset Management Commission acts as the owner for the state-owned shares. These share holding companies share some features with modern corporations, such as having a board of directors. However these firms are continuing to operate under the conventional SOE system. The state owns the majority of shares. Top managers, including the president of the board, are still appointed by the State Asset Commission and there is no supervisory board. The authority for making important decisions therefore still rests with the government rather than with its board of directors. Thus, the share-holding system has not changed the nature of SOE operation even if there has been some change in structure. This has been described by several managers as 'changing the soup but not changing the herbs in it'.

A problem related to government interference is that managers and workers in state-owned firms have low incentives to make the firm profitable. Since the government appoints managers for SOEs, there is no guarantee that talented people will be selected or even promoted because government offices such as the State Asset Commission do not bear the responsibility for the firm's performance. The appointed managers often do not bear the responsibility either. As a result poor business practices such as bad investment decisions are common. For example, the State Asset Commission of Shenzhen holds 56.16 percent of the shares in Shenzhen Telecommunication LTD. This company set up more than 30 firms after it became a share-holding company. The resulting division and duplication of its resources resulted in high costs and low returns for each firm. The firm(s) has a large management body operating in a similar way to a bureaucratic organisation. They have been making losses since 1990. Despite this, no managers have been changed and the atmosphere in the firm is relaxed. In state-owned firms, not only are bad decisions by managers not penalised, good performances are not rewarded. There are no differences between the income of loss making managers and those who are making profits.

Workers also have little incentive to work hard. State-owned firms are still unable to hire or fire workers freely. The manager of Saige Electronics LTD complained that many measures to improve efficiency can not be implemented in state firms because employees oppose them. Interviews with managers reveal that when workers get jobs in firms with foreign investment, they are prepared to earn their money by working hard and bearing the consequences of their behaviour. In many workers' mind, being fired by a foreign investment firm is considered a reasonable behaviour for the firm if workers cannot deliver satisfactory work. This is not the case when workers are employed in state-owned firms. The reason is that workers think a FDI firm belongs to the boss, while a state-owned firm belongs to the people, including the employees themselves. As the owners of the firm, they feel they should not be constrained by strict rules.

The income distribution in SOEs is disconnected from the firms performance. The wage differences between the maximum and minimum for workers in the SOEs interviewed is below 200 Yuan per month. This differences does not reflect the performance differences and reward talented workers. On the other hand, people with power enjoy many hidden benefits such as privileges in housing, cars, and banquets using firm funds. This often induces corruption and causes dissatisfaction of workers. As a result, shirking is common.

A heavy historical burden is another problem state-owned enterprises face. This burden is firstly from over-staffing. About 30 percent of SOE employees in the firms interviewed are considered surplus by managers interviewed. SOEs also bear the obligations to take care of their employees. Tianguang Integrated Circuit Company has been making losses for a long time, however, cutting wages and the bonus bill is not on the agenda. Despite its losses, the income for a secretary is about 2,500 Yuan per month, and for a middle level manager is about 4,000 Yuan a month, which is higher than the average income level for public servants in similar ranks.

Most state-owned enterprises interviewed suffer from high indebtedness. The survey shows SOEs' average total debt to asset ratio stood at about 70 percent. This continuous loss making situation causes the firm to face a shortage of capital, which in turn creates difficulties in the firms' operation. About 60 percent of the managers interviewed also think SOEs are facing unfair competition from other kinds of firms because those firms are not restricted in their range of business strategies as state-owned firms are. All these problems indicate that reform so far has not been successful in revitalising state-owned enterprises.

The case studies revealed that in contrast to state-owned firms, most collective firms are basically guided by market forces. The governing bodies for the collective firms are somewhat complicated. Out of the seven collective firms interviewed, three belong to district or county governments, one was set up by a government department in a different province to take advantage of the location of Shenzhen, and three are in fact privately owned and registered as collectively owned firms.

The degree of government interference is much lower in the collectively owned firms than it is in SOEs. The collective firms that are actually privately owned operate as private firms. Maintaining a good relationship with local government is based on their own commercial interests rather than allowing the government to make business decisions. The situation for the collectively owned firms which are owned by local governments is not as simple. However, the firms are also operating under market forces, because the firms have to compete for survival. Some managers think the firms will sooner or later become private so they operate the firms to some degree as though they are their own firms. This suggests that many collectively-owned firms are collective rather than private only because of the current political situation in China.

The firms have the autonomy to hire or fire workers. The wage gap between skilled and unskilled employees in collectively-owned firms is much larger than that in the state-owned firms. The minimum and maximum wage for workers in the same firm can reach up to 1,000 Yuan per month, five times as high as the figure for the state firms interviewed. Since the incomes and job security of workers are closely related to the profits of the firms, they have a strong incentive to work efficiently.

Collectively-owned firms have to bear the consequences of their performance. The experience of the Baoyun Food and Beverage Company illustrates some features of collective firms in China. The firm was founded in 1982 by several farmers in Baoan county. At that initial stage of its operation, the firm easily made large amounts of profit because of the managers' risk-taking behaviour. However, the profit level of the firm decreased from 1991 when the market became more competitive, and consumer tastes became more sophisticated. In 1993 the managers took some bold decisions in buying shares resulting in losses to the firm. In 1994 several managers were replaced and the investment decision was reviewed. The firm became profitable again from 1995. The manager interviewed thought that being farmers, they were still learning as they went from their experiences about how to manage a firm well.

Enterprises with foreign investment have the right to manage themselves, provided that they observe Chinese laws and regulations. In general, the government does not interfere in the administration of these enterprises. They operate under the labour contract system, and can hire and fire workers freely. Enterprises are also allowed to pay floating wages and salaries, or to pay by piece. Foreign investment firms often offer higher wages than other firms. The monthly average wage of a worker in a state-owned firm is about 1,200 Yuan, while that for a worker in collectively-owned firms is about 800 Yuan, and in an FDI firm it is about 1,600 Yuan. However, FDI firms usually do not spend on employees' welfare. This makes the labour cost of FDI firms much lower than that of state-owned firms. The wage gap is large between employees with different skills and positions in foreign investment firms. For example, the annual salary for the foreign general manager of the Huayun Electronic Company is about US$ 110,000, while that for a middle level manager of the firm is about US$ 40,000. Table 8.3 is the wage distribution from one of the FDI firms in the electronics industries interviewed.

Table 8.3. Wage distribution in a FDI firm (Yuan/Month)

	Managers	Head of Workshops	White collar workers	Blue collar workers
Within a year	3400	2200	1300	1000
Over three years	4800	3000	1500	1200
Over five years	8000	4500	2200	1700

Workers in FDI firms in manufacturing industry are generally paid by piece. Wages are related to the contribution of employees to the workplace. The bonuses of FDI firms are strictly allocated according to the performance of workers, which adds incentives for workers to work hard. At the same time, wages increase according to the time of employment, this can reduce the out-flow of the workforce.

FDI firms are responsible for their performance. SANYO's Shenzhen branch has been very profitable, yet its Beijing branch was closed down due to a bad investment decision. The Red Peony Garment Company is a joint venture with a Hong Kong garment factory which produces silk garments. The firm has been making large profits since is was set up in 1984. More than 95 percent of its products are exported to Europe, America, and Southeast Asian countries. However, since 1994 its production has dropped to below 70 percent of capacity because of US restrictions on textile imports from China. The market is also becoming more competitive because the number of garment firms has increased. As a result, the Red Peony Company has also had to reduce its number of staff and their wages.

8.2.2 Firms' Preferences for Government Policies

The different nature and problems that firms face means that they have different requirements from government policies. Table 8.4 summarises the responses from state-owned enterprises in this area. It is not surprising that over 70 percent of state-owned firms interviewed want less government interference, and more freedom in hiring and firing of labour. At the same time, however, some mangers in state-owned firms also think SOEs should be subject to government control because they are not private property. While most firms prefer to have more autonomy in the decision making process, it is also common that firms require special treatment in terms of loans, tax, and land access. For example, the Yili Beverage Corporation has the ambition to become the largest beverage company in China by merging several small companies. The manager thinks that they should be supported by government through lowered tax rates and easier access to land. Some firms also think that government should protect national industry by restricting imports and FDI. These kinds of response demonstrate that the mentality of depending on the government still exists in the mind of some SOE managers.

Six managers interviewed think they are in a disadvantaged position compared with FDI firms because the government offers special incentives, such as tax reduction, to the latter. Such special treatment is considered as a 'betrayal' by some managers with strong nationalistic ideas.

Table 8.4 Policies requirements of state-owned enterprises

Policies	Number of responses	Percentage in total state-owned firms interviewed
Reduce government interference	7	70
More freedom in hiring and firing workers	8	80
More freedom in import and export	4	40
Special treatment in bank loans	4	40
Special treatment in tax, land, etc.	3	30
Eliminate special treatment for foreign invested firms	6	60
Protecting firms in certain industries	5	50

The close relationship between the government and SOEs not only impedes the ability of state-owned firms to deliver good performance, but also causes problems for non state-owned firms. About 70 percent of the collectively-owned firms interviewed think they are discriminated against in getting access to resources such as bank loans, land, and usage of basic infrastructure. They hope they can be treated equally and the government can allocate resources according to firms' commercial performance.

Many managers in FDI firms think the frequent changes of government policies were bad for business confidence (Table 8.5). Four firms think the close relationship between government and state-owned firms pose some difficulties for their firm's operation. Most firms felt they could compete effectively in a level playing field. Therefore, further free market reform is welcomed by most firms.

Table 8.5 The police preference of foreign invested firms

Policies	Number of responses	Percentage in total FDI firms interviewed
Reducing the frequency of policy change	6	60
Improving the efficiency of government department	5	50
Improve the condition of basic infrastructure	6	60
More support for cooperation between firms and research institute	4	40
Opening domestic market	6	60
Reducing forced donations	4	40
Reduce close relationships with state-owned firms	4	40

8.2.3 Firms' Attitude to Technological Development

8.2.3.1 Technology Gap between Domestic Firms and FDI Firms

The technology gap between domestic firms and FDI firms can be indicated by firms' conditions in machinery, R&D spending, and skilled employees (Table 8.6). Table 8.6 reveals that there is not much difference between the SOE and FDI firms in terms of machinery imported since 1990. In contrast, the difference between FDI firms and collectively-owned firm is much larger in terms of imported equipment. In terms of importing technology, the percentages are lower for both state and collectively-owned firms relative to FDI firms. SOEs have tended to import hardware and pay low attention for software because, for a long time, hardware components are considered to be much more important than the software. However, low effort has been devoted to obtaining and mastering software. Over 80 percent of collective firms interviewed indicated that their technology and equipment importation would be increased with their financial capability.

The ratio of R&D in sales revenue is higher for collectively-owned firms than it is for SOE firms. This ratio seems low for FDI firms too. However, given that most FDI firms import technology from parent companies, the real spending of FDI firms in

R&D could be considered high. The proportion of employees who are technicians is slightly higher for FDI firms than it is for SOEs, while the proportion is low for collectively-owned firms.

Table 8.6. Comparison of technological conditions

Items	SOEs		Collectively owned firms		FDI firms	
	No. of firms	%	No. of firms	%	No. of firms	%
Imported equipment since 1990	7	70	3	43	8	80
Imported technologies since 1990	4	40	4	57	7	70
Percentage of R&D spending in sales ratio (%)						
0-1	3	30	1	14	2	20
1-3	7	70	3	43	7	70
3-5	0	0	2	28	1	30
above 5	0	0	1	14	0	0
Percentages of technicians and engineers in total employees (%)						
0-10	1	10	2	28	0	0
10-20	4	40	3	43	2	20
20-30	4	40	1	14	6	60
Above 30	1	10	1	14	2	20

A number of interesting points can be derived from these findings. First, the major differences between SOEs and FDI firms lie in the way they utilise technological resources, rather than in the amount of advanced equipment they possess and proportion of their skilled staff. Many SOEs interviewed possess advanced equipment because the Government has encouraged SOEs to update their technology and equipment by offering financial support since 1992. An SOE firm such as Shenzhen Petro-Chemical Corporation has over 80 percent of its equipment imported, and equipment is upgraded frequently. However, these expensive machines are often under-utilised. Similarly, the main equipment of the Yunhong Electronic Company was imported from the USA, Canada, Finland, and Japan, and was considered advanced. However, this advanced equipment have not been able to prevent the firm from making continuous losses. The loss making situation resulted in a shortage of capital. As a result, since 1995, some projects to upgrade technology have been stopped or cancelled altogether.

The same situation is true for technical staff. About 60 percent of managers interviewed thought they had sufficient people with higher education degrees. However, they complained that their technical staff were not playing active roles in R&D. For example, although over 30 percent of the employees in Shenzhen Telecommunication LTD have tertiary qualifications, and there is an R&D section within the firm, the firm has not produced any innovations. The problem of how to channel the talent of technical personnel into more productive activities remains unresolved.

SOEs also have low spending on R&D. Four SOE managers interviewed attributed their low rates to the lack of an effective system to protect intellectual property rights. They think the return in technology investment is low or even negative because innovation is easily diffused when employees move to a different firm. Even when there is no labour movement, some innovations are sold by some employees. Firms financial difficulties also add to the low capability of firms to engage in, and benefit from, innovations.

Compared with state-owned firms, the lack of resources, in terms of both physical capital and human capital, is obvious in collectively-owned firms. Collectively-owned firms have long been denied access to raw materials and foreign exchange to import technology and equipment. Four out of seven collectively-owned firms interviewed mentioned that they have purchased old equipment from state-owned firms at some stage. About 57 percent of firms interviewed felt they have had difficulties in attracting talented employees to work for their firms. Collectively-owned firms have less imported equipment and technology than FDI firms. However, it seems that collectively-owned firms are doing better in utilising their limited technological resources than SOEs. On average, collectively-owned firms also spend a higher proportion of sales revenue on R&D. Overall, FDI firms possess richer resources and are more engaged in terms of importing technology and equipment.

8.2.3.2 The Technology Gap in a Broader Sense

In order to better understand the differences between domestic firms and FDI firms in a broader sense, the managers in state and collectively owned firms were asked to identify the disadvantages they face compared to foreign investment firms in terms of technology, management, marketing, brand names, and after sales service. The basic responses are presented in Table 8.7.

Table 8.7 Disadvantages of domestic firms compared with FDI firms

Areas of disadvantages	State-owned firms		Collectively owned firms	
	No. of responses	% in total SOEs interviewed	No. of responses	% in total collectively owned firms interviewed
1. Management	10	100	5	71
2. Production through better technology	4	40	6	86
3. Better quality intermediate inputs	4	40	4	57
4. Skilled manpower	4	40	5	71
5. Marketing	9	90	5	71
6 Quality of the product	6	60	5	71
7. Competitive prices	4	40	2	28
8. After sales service	6	60	3	42
9. Name and image of companies	6	60	7	100

The responses confirm industrial organisation theory in the sense that foreign investment firms have advantages over domestic firms in a variety of aspects. However, the content of the technology gap between domestic firms and foreign investment firms differs for state and collectively-owned firms.

A high percentage of SOEs consider that that FDI firms possess superiority in management and marketing and a relatively low percentage of SOEs think there is a big gap between them and FDI firms in terms of production technology and skilled manpower. In contrast, more collectively-owned firms think the gap in production technology and technical manpower is wide between them and FDI firms. Both kinds of Chinese firms acknowledge that there are differences between domestic firms and foreign investment firms in terms of brand names and after sales services. Several managers also consider that they have disadvantages in the quality of intermediate input because FDI firms have more freedom to import inputs. This situation is especially true for firms such as the Shenzhen Petro-Chemical Corporation because the government still controls the supply of inputs in these industries.

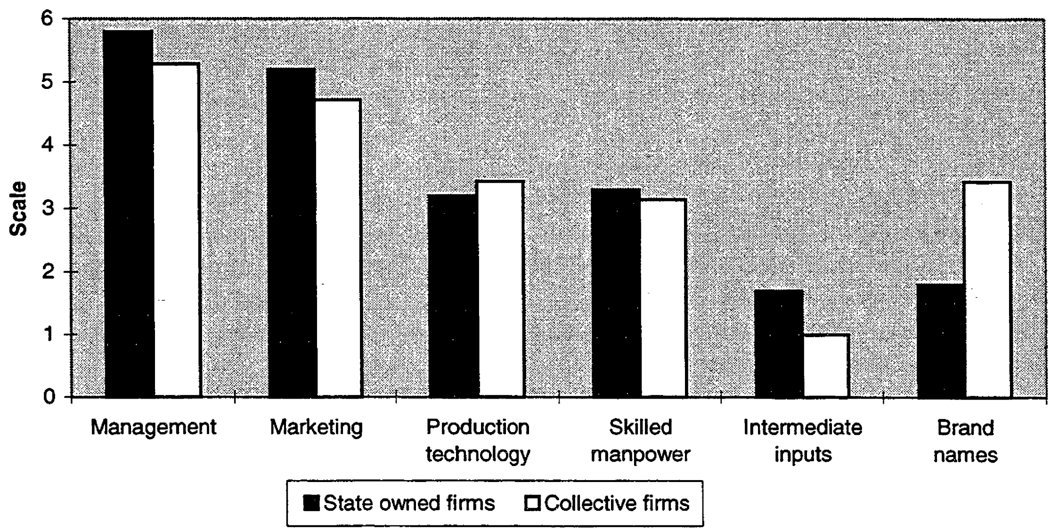
The reasons that managers in SOEs attach great importance to management and marketing is closely related to the nature of SOEs. All managers interviewed think that SOEs not only lack the skills in management ,and marketing compared with MNCs, but also have a more rigid operation systems. Many managers think the main factors are outside their control and there is not much they can do in an increasingly competitive environment. While most collectively-owned firms also admit the gap between FDI and collectively-owned firms in terms of management and marketing, they emphasise that the gap is mainly in skill rather than relating to the nature of firms.

Given the technological gap the firms perceived, the managers were also asked to further evaluate the relative importance of management, marketing, technical staff, product and process technology, and brand name. They were asked to give a ranking in an ordinal scale from 1 to 6, with the higher number representing the greater importance the firms attached to the criteria. The ranking of each firm is summarised and then averaged to compare the relative importance. The bar figure based on this information is presented in Figure 8.1.

Most firms ranked the criteria in the following order of importance: management, marketing, technical personnel, and product and process technology such as equipment. They pointed out that only a good management team can fully utilise a skilled workforce and equipment. Marketing skills are important in increasing the demand for firms' product and improve firms' ability to improve technology.

For respondents from state-owned firms, the greatest constraint was the way the firms were managed. For example, one manager of Saige Electronic LTD mentioned that they had spent a large amount of money on upgrading technology with little achievement because the investment in technology was scattered into several small projects with no obvious returns from any of the projects. The manager thought it impossible to achieve technological advantage without an efficient management structure to accommodate the task of technology upgrading.

Figure 8.1 Relative importance of different technological aspects as assessed by Chinese firms



In summary, it can be said that the gap between SOEs and FDI firms is firstly a management gap, and only secondly a technology gap. While collectively-owned firms also face a gap in management skill between themselves and FDI firms, this gap is smaller than that between SOEs and FDI firms. In China, management has been considered by the government as only the third most important factor for firms. Yet these case studies suggest that the management gap may be even more important than the technology gap. Developing new technology has been considered by all SOE managers and over 70 percent of managers in collectively-owned firms as a means to an end, rather than the end in itself.[2] Only when the firm is efficient in allocating resources, can technology upgrading play an important role. This may explain why many SOE managers are more pessimistic about their prospects compared with managers from collectively-owned enterprises, even though state-owned firms generally possess better equipment and more technical staff. In contrast, many managers in collectively-owned firms are confident of their firms' future despite their technological inferiority.

[2] The ends pursued by the two kinds of firms might be different.

8.2.4 Channels of Spillover Effect

Four channels are frequently suggested in the literature as avenues by which the entry of foreign firms stimulates domestic firms' productivity growth. The first is the increased competition generated in the local market. The second is the enhancement of human capital formation via training of local employees, and through labour mobility, or turnover from foreign invested firms to domestic firms. The third is technology transfer through the demonstration effect, and the fourth is through backward and forward linkages.

Spillovers through increased competition

All domestic firms interviewed stated that they face strong competition from FDI firms. However, in the face of intensive competition and its resulting shake out, firms with strong development incentives emerged better placed in the market. State-owned firms and collectively-owned firms demonstrated great differences in this respect. These differences are evident from the experiences of several firms interviewed.

Shenzhen Telecommunication LTD is a state-owned share holding company in which the State Asset Commission of Shenzhen owns nearly 60 percent of shares. It has been running at a loss since 1993. This continuous loss making increased the firm's shortage of capital. The debt to net fixed capital ratio reached 80 percent. Facing increased competition caused by the entry of a large numbers of MNCs such as Philips and SIEMENS into the telecommunications industry, the firm imported some new equipment and tried to reform its way of operation. However, because of its rigid and inefficient way of operating, the existing human and physical capital are not able to play effective roles. The manager thinks the firm benefited little from MNC introduced technology. On the contrary, the large MNCs are crowding the Shenzhen Telecommunication LTD and other national industries out of the domestic market. Such concerns reflect the view of many mangers of state-owned firms interviewed.

A subsidiary in the state-owned food and beverage company Yili Beverage Corporation formed a joint venture with a French company to utilise the technology and capital of the foreign company. The joint venture does not provide welfare benefits to its employees, has higher requirements for workers' performance, and can hire and fire workers freely. It has been making a profit since it was set up in 1990. However, the higher level managers of the company are considering stopping the cooperation by buying back all the shares owned by the foreign investor. The reason for this action is that the joint venture has created competition to state-owned firms in the company. Workers who have not delivered satisfactory work have been fired by the joint venture, but they then have been taken back by other state-owned firms in the company.

A totally different story happened to a collectively-owned firm in the food and beverage industry. One firm in Shenpao Food and Beverage Company formed a joint venture with Pepsi. Before forming the joint venture, the firm was producing products such as ice tea which had little market demand because of their poor quality and unknown brand name. The cooperation with Pepsi increased the efficiency of the firm through the adoption of a different operation system, enlarging the market network and expanding the sources of funds, which further promoted production and export. The joint venture also created competitive pressure to other firms in the company. This pressure manifested itself as strong incentives to improve efficiency of production. Since 1993, profit in most of the branches has increased.

The entry of foreign investment firms increased competitive pressure in the Chinese market. The increased competition accompanied by the entry of FDI firms has pushed the domestic firms to improve efficiency and upgrade technology. However, only when the pressure is combined with internal incentives to be competitive, and structural flexibility, will it be possible for the domestic firms to move towards best practice.

Spillovers through demonstration effects

Host countries can benefit from FDI through the examples foreign companies provide. As a result of exposure to new production and marketing techniques, domestic firms may improve the technology by observing nearby foreign firms. Because of the tacit components of technologies, demonstration is often essential for local firms to recognise the feasibility and to imitate the technology.

Of the 10 state-owed firms interviewed, only 3 indicated that they benefited through learning by watching. However, 5 out of 7 collectively-owned firms interviewed think that they improved their performance by 'observing practices in foreign companies' and 'obtaining know-how from foreign companies'.

Several managers in SOEs recognise that the firm can learn from the MNCs by analysing the products of MNCs sold in the local market. However, not much work has been done on this strategy because the development of a new product often takes a long time. The managers do not want to take risks and to gain returns for his successors. Some managers said that if state-owned firms had not been subject to heavy social burdens and managerial constraints, they could have performed better under the influence of foreign firms.

Interviews with the managers of collectively-owned firms show that collective firms have endeavoured to catch up with foreign investment firms, and have actively sought new ideas for improvement. For example, the collectively-owned garment firm Linfei Garment Company thinks it has improved product design by studying the products sold in the market by FDI firms.

Chinese firms surveyed were also asked to indicate in which areas they believe local firms have gained most from observing foreign investment. Of the various types of potential influence, over 75 percent of the managers interviewed attributes the main foreign skills obtained by domestic firms to management and marketing skills. Other areas included product design and, to a lesser extent, production process. The demonstration effect of modern management and marketing techniques are important because, as has been mentioned before, the difference between domestic and foreign investment firms lies mainly in management and organisation rather than in equipment.

Labour movement

Spillovers may occur as a result of labour turnover as employees move from foreign to domestic firms. All domestic firms interviewed think the most effective way to learn from a foreign investment firm is to work in a foreign firm for some time and to observe the way the foreign firm operates. The magnitude of this effect depends on the extent to which the employees in the foreign investment firms are trained, as well as the mobility rate of labour.

Case studies have shown the foreign firms initiate more on-the-job training programs than their domestic counterparts (Table 8.8).

Table 8.8 Number of firms engaging in regular training

	No. of firms	% in firm of each category interviewed
State-owned enterprises	6	60
Collectively owned enterprises	5	71
Foreign invested firms	8	80

These trained employees from FDI firms would certainly bring benefits to local firms if they move to local firms. However, the survey shows that domestic firms in China, especially state-owned firms, are not benefiting from labour turnover. While sixty percent of foreign investment firms interviewed indicated that there is frequent labour mobility between firms, this mobility is mainly between foreign invested firms. Few employees have moved to domestic firms.

Several managers stated that there were some employees who had moved into state firms to seek their welfare benefits and job stability. However, this flow is diminishing as the welfare benefits decreases with the poor performance of state-owned firms. Moreover, these employees often belong to those who cannot cope well in foreign investment firms. Few of them are technical and management staff, and their moving-in rarely enhances spillover effects.

On the contrary, the entry of better endowed FDI firms drains the limited supply of skilled labour from state-owned firms. Managers from all the ten state-owned firms interviewed stated that there are talented employees moving out to FDI firms in their firms. Employees moving to foreign investment firms from state-owned firms are usually talented people, such as high level engineers, accountants, and designers. Their moving out not only lowers firms' technological capability, but it can also remove technical information and possible market connections. This suggests that spillover effects through staff movement may actually have a negative effect on state-owned firms in China.

Interviews with Chinese managers employed in foreign investment firms revealed that the reason why skilled people are attracted to foreign investment firms is firstly because of the relatively high wages FDI firms offer, and secondly, the flexible management system provides chances for talented people to utilise their skills. Their effort and talent are also better rewarded in foreign invested firms.

The labour movement to collective firms is not widespread either, mainly because of wage differences. However, some people who gained experience in foreign investment firms tend to set up their own businesses which are often registered as collectively-owned firms. One manager in SANYO Electronic Company mentioned that their engineers and technician's outflow is often directly connected with the establishment of new firms. Some well endowed companies such as Huawei Telecommunication Corporation have also attracted people with experiences of working in foreign investment firms. More than 10 percent of its employees have worked in foreign investment firms. Management skills and production technology are diffused to local firms when employees move to domestic firms or set up their own firms.

Mobility of skilled labour from foreign investment firms facilitates information and technology transfer. However, when domestic firms are not able to attract skilled workers to move in, exchange of information through labour mobility comes at a significant cost to the domestic firms. Nineteen out of twenty seven managers interviewed indicated that they are not concerned about which kind of firms they are working for, but rather emphasise their income, and whether their abilities can be appreciated and utilised. Therefore, with the diminishing of wage gaps between domestic and FDI firms, and development of the labour market, more employees are expected to move between domestic firms and FDI firms.

Forward and backward linkages

The linkage effects include backward linkage and forward linkage effects. Forward linkages arise when foreign investment firms sell products to domestic firms.

Backward linkages take place when domestic firms supply inputs to foreign investment firms.

Forward linkages

Forward linkages are related to the extent to which domestic firms purchase products produced by foreign firms. Forty percent of state-owned firms and seventy one percent of collectively-owned firms interviewed indicated that they had purchased inputs from FDI firms. This was because the product quality of foreign investment firms are generally higher. Managers in these firms think the use of better quality products from FDI firms improves the quality of their products. They also mentioned that the reputation of their products improved because consumers show more trust knowing their products use inputs from MNCs.

Some technologies are also transferred through technical assistance and after sales services. In this respect, six foreign investment firms interviewed indicate they have had better cooperation with collectively-owned firms because of their simpler institutional arrangements and because they are more keen to improve.

A large proportion of products produced by wholly foreign owned firms have to be exported according to government policy. Firms such as SANYO Electric LTD and Chaosun Machinery Corporation have to export 100 percent of their products. Forward linkages are expected to be higher with the opening up of the domestic market.

Backward linkages.

Backward linkages occur when foreign firms act as a source of demand for local input. The purchase of local products and services can often force local firms to improve the quality and the standard of products. The spillover through backward linkage depends upon the degree to which foreign investment firms are buying local products. The backward linkages in the Chinese market seem weak. Five out of ten managers in FDI firms interviewed stated that they either import their inputs or purchase from other foreign investment firms. Out of the five managers, two stated that they are not very confident in the quality of products produced by domestic firms. Two indicated that they do not want to get involved in legal arguments with a Chinese firm, especially a state-owned firm, should the agreement not be fulfilled. One mentioned that it has a long term foreign supplier and is willing to continue that cooperation. Five FDI firms interviewed buy part of their inputs from local suppliers. However, these purchases are mainly of raw materials and labour intensive products.

All the managers in FDI firms interviewed indicated that they would like to build reliable corporations with local suppliers. Currently, both state firms and collectively-owned firms presented problems for such an endeavour. The problems with state firms lie in their complicated management system and the close relationship with the government. The problem with collectively-owned firms lie in their inexperience, and mentality of seeking large profits based on short term behaviour. But over time, it seems collective firms are gaining more experience and building better reputations for themselves among foreign invested firms.

The backward linkage effect between FDI firms and local firms identified by the case studies seems weak. However, the linkages can be expected to improve with the development of domestic firms and the marketisation of the Chinese economy. This could also result from the biases arising from the small number of firms in the sample. A larger sample size may be needed to be able to obtain more detailed and accurate information.

8.3 Comparison between Firms in High and Low Technology Industries

8.3.1 The Technology Gap between Domestic and Foreign Invested Firms

One of the clearly specified goals of the Shenzhen government is to attract FDI with advanced technologies, and to make Shenzhen one of China's science and technology bases. To achieve this goal, the government has set up a Science and Technology village. Firms which produce labour intensive products have been asked to move out to surrounding counties and towns in order to leave space for firms in high tech industries. However, despite the government's ambition, there was little sign that foreign investors viewed Shenzhen as a good location for high-tech industries. Most of the investment has been in simple assembly rather than original manufacturing or R&D. Could Shenzhen become a high tech city in a short period of time? Was it reasonable to expect FDI firms to introduce a large amount of advanced technology into Shenzhen? The comparison of spillovers between high and low tech industries can shed some light on these issues.

According to the criteria outlined in chapter 7, firms in industries such as telecommunications, electronics, machinery, and petro-chemicals will be considered as part of the high tech category, while firms in garments and the food and beverage industry will be considered as part of the low tech category. Based on this criteria, firms in high and low tech industries interviewed are listed in table 8.9 below. As has been discussed in chapter 7, it is complicated and to some extent subjective to classify high and low tech industries. Therefore, the classification is more based on relative features rather on absolute indications.

Table 8.9 Firms interviewed according to high and low tech industries

	High tech industries	Low tech industries
State-owned enterprises	7	3
Collectively owned enterprises	4	3
Foreign invested firms	4	6
Total	15	12

In order to compare the technological differences between domestic and FDI firms, questions were asked regarding the situation of firms in terms of imported equipment, R&D to sales ratio, and percentage of engineers and technicians for firms in different industries. The responses are presented in Table (8.10).

FDI firms were found to be more oriented towards new technologies than domestic firms. A higher percentage of FDI firms imported equipment and technology than domestic firms. This is especially true for firms in high tech industries where one hundred percent of FDI firms were found to have imported significant amounts of technology and machinery since 1990. FDI firms in high tech industries also maintain a higher percentage of technicians and engineers. The differences between the ratio of R&D in sales revenue does not seems to be large between FDI firms and domestic firms. However, all of the four FDI firms in the high technology industries mentioned that they benefited from the research and development work carried out by their parent companies. The real gap in R&D spending between domestic firms and FDI firms is therefore expected to be high, particularly in the case of high tech industries.

Table 8.10 Comparisons of technological conditions based on industries

Items	Firms in high technology industries				Firms in low technologies industries			
	No. of Chinese firms	% in total no. of Chinese firms	No. of FDI firms	% in total no. of FDI firms	No. of Chinese firms	% in total no. of Chinese firms	No. of FDI firms	% in total no. of FDI firms
Imported equipment since 1990	7	64	4	100	3	50	4	67
Imported technology since 1990	6	54	4	100	2	33	3	50
Percentage of R&D spending in sales ratio (%)								
0-1	1	9	0	0	3	50	2	33
1-3	7	64	3	75	3	50	4	66
3-5	2	18	1	25	0	0	0	0
above 5	1	9	0	0	0	0	0	0
Percentages of technicians and engineers in total employees (%)								
0-10	0	0	0	0	3	50	0	0
10-20	4	27	0	0	3	50	2	33
20-30	5	45	2	50	0	0	4	67
Above 30	2	18	2	20	0	0	0	0

The interviews reveal that FDI firms are able to import newer and more advanced technologies from their parent companies, while the technologies imported by domestic firms are generally 3 to 5 years behind the advanced international standard. Some technologies imported by domestic firms have already been updated in the home countries. Overall, the responses indicate that there is a bigger technology gap between FDI firms and domestic firm in high technology industries than that in the low technology industries.

The technology gap between domestic and FDI firms within industry sectors can also be analysed in a broader sense to incorporate differences on factors such as management and marketing. Table 8.11 present the disadvantages identified by domestic firms in comparison to FDI firms.

Table 8.11 Disadvantages of domestic firms compared with FDI firms based on industry differences

Comparative advantage	Chinese firms in high tech industries		Chinese firms in low tech industries	
	No. of response	% of responses	No. of response	% of responses
1. Management	10	91	5	83
2. Production through better technology	8	73	2	33
3. Better quality intermediate inputs	6	54	2	33
4. Skilled manpower	7	64	2	33
5. Marketing	9	82	5	83
6 Quality of the products	8	73	3	50
7. Competitive price	2	18	4	66
8. After sales service	7	64	2	33
9. Name and image of companies	8	73	5	83

High percentages of firms in both high and low tech industries consider that FDI firms maintain advantages in management, marketing, quality of intermediate inputs, brand names, and image of companies. However, a much lower percentage of firms in low tech industries consider that there is a gap between them and FDI firms in terms of production technology, skilled manpower, and after sales services. Overall, FDI firms have advantages over local firms in terms of management and market connections. However, the technological advantages of FDI firms mainly exist in high technology industries.

8.3.2 Comparison of the Channels for Spillover Effects

Spillovers through increased competition

Increased competition forces FDI firms to speed up innovations. However, despite the technological gap between domestic firms and foreign investment firms, this survey found that foreign investment firms in China are generally not operating with cutting-edge technologies as the government wished. FDI firms conduct limited R&D in China, as Table 8.10 revealed. Even less R&D is undertaken that contributes to fundamental product and process innovations. FDI firms' R&D activities were found to be confined to development research which sought to adapt foreign technology to suit Chinese conditions. For the firms participating in this study foreign investment has brought very limited impact in terms of R&D.

When asked why this is the case, four managers in FDI firms indicated that the Chinese market had for a long time been a sellers' market. Therefore firms have been able to survive in the Chinese market using designs which have remained unchanged for quite a long time. These managers stated that they have been able to rely on parent firms conducting R&D. However, 80 percent of FDI firms interviewed are planning to increase R&D spending because the market is becoming more competitive with the entry of a large number of MNCs. For example, SANYO has set up a venture specifically for conducting R&D in China in 1995. The interview of managers in FDI firms shows that the competition they face is mainly among FDI firms themselves, rather than from domestic firms.

Competition from FDI also pushes domestic firms to improve levels of efficiency and technology. In this respect, Chinese firms in high and low technology industries face different situations. When asked whether the competitiveness of FDI firms mainly lie in price or quality of products, 73 percent of Chinese firms in high technology industries mentioned that foreign invested firms possess advantages because they produce high quality products (Table 8.11). The price factor becomes more important in the low technology industries, where 67 percent of firms think that competition is mainly in price, and over 50 percent of domestic firms found themselves able to compete in the market based on the low cost of their products.

There is evidence from the case studies that spillover is strongest between firms with similar levels of technology. About 83 percent of Chinese firms in low technology industries think that the well run foreign companies helped them to identify the weak links in management, product design, material supply, and spur them to undertake changes they might not otherwise have considered. For example, an interview with the manager of the Linfei Garment Company indicated that competition had pushed them to import sewing machines from Japan, send technicians to receive training in some universities, and adopt computer designing. While admitting the fierce competition from FDI firms, the manager interviewed thought there was not a big technology gap between his firm and FDI firms. He was confident that the firm could survive and develop.

While most firms think increased competition has pushed them to improve performance, many firms in the high technology industries face tremendous difficulties. The problems Chinese firms in high tech industries face relate particularly to technology absorption rather than technology acquisition. Most managers interviewed think they do not have technological capability to assimilate technologies brought in by FDI firms. On the contrary, the competition from FDI have largely crowded many domestic firms out of the market. One managers described the situation of the entry of large MNCs as 'putting wolves into a group of sheep'.

Of the firms interviewed, Huawei Telecommunication Corporation provides an exceptionally good example of a well performing Chinese firm in a high tech industry. The firm was founded in 1988 as a collective firm by several engineers from some state-owned firms. All of its 3000 staff have at least undergraduate degrees, of whom over 40 percent have masters and above degrees. The company is not only able to master technologies imported, but has also been able to develop more than thirty new integrated circuits.

Two main methods have been used to develop competence within the company. Mastering of state-of-the-art technology has been given much attention because the managers of the firm think that without innovation, the firm will always have to catch up from behind rather than possess technology superiority. More than 10 percent of the firm's sales revenue have been invested in R&D. Great emphasis has also been placed on marketing, as the firm realises the scale for production must be supported by demand for the products. The marketing section is increasing at a rate of 200 percent every year since 1990. Overall, forty percent of the employees are engaging in R&D, 35 percent in marketing, 12 percent in management and administration, and only 13 percent in production.

As an outstanding Chinese firm, it has been promoted as a national icon and a model to emulate for other firms. The firm has been praised by different levels of government officials, even including President Jiang Zemin. Even so, the managers of the firm think it was a naive decision to select the telecommunications industry to compete with large MNCs such as AT&T, NEC and SIEMENS. The manager interviewed admitted that the founders of the firm were ignorant about the strong competition in the market. In spite of a clear strategy and an exceptional effort to catch up, the company continued to face problems in developing its technological capabilities. For example, even through it has imported advanced technology, overall its equipment lagged behind that of the international leaders by about 5-8 years. The products of the firm are not easily accepted by the consumers. It was not until June 1996 that Huawei started to supply telephone exchangers to the Guangdong market based on support from the local government. Despite the achievement of the firm, it seem it is still too early to be totally optimistic about the firm's future.

Spillovers from demonstration effect

A high proportion of Chinese firms in both the high and low technology categories think they have benefited from management and marketing skills derived from FDI. A higher percentage (67%) of firms in low technology industries benefited from FDI designs than firms in high technologies (36%). This is mainly due to fact that designs in low technology industries such as garment industries are easier to imitate. In terms of production technology, only 18 percent of firms in the high technology industries think they have benefited from FDI firms (Table 8.12). In order to imitate foreign technology, domestic firms must be actively engaged in R&D in order to search for information on what technologies are available and under what condition these technologies can be purchased or modified and applied. In many cases it is very hard to gain this information because foreign firms would not allow their Chinese counterparts access to technical knowledge and blueprints for commercial reasons. Chinese firms in high tech industries often face difficulties in gaining information about new software. Very few foreign companies are willing to sell this information, let alone to provide it freely. FDI firms in high technology industries are especially careful in protecting their technology from leaking to their competitors. For example, none of the four FDI firms in high technology industries interviewed allow visitors to watch their production processes. They even have rules to stop their own workers from learning processes other than the specific process they are engaging in. Most Chinese managers in the high tech industries think it is very hard to obtain production technology from FDI firms due to its tacit nature and foreign investors' active effort to reduce technology spillovers.

Table 8.12 Technology learned by domestic firms through demonstration effect

Types of technology	Firms in high technology industries		Firms in low technology industries	
	No. of response	% of response	No. of response	% of response
Production technology	2	18	4	67
Design	3	27	5	83
Management techniques	5	45	5	83
Marketing skills	5	45	4	67

One of the purposes behind the Chinese government seeking to attract FDI into China was to 'exchange market for technology'. However, the president of Huawei thinks very little cutting edge technology has been leaked to Chinese firms even though the market share of many MNCs is increasing. In some cases, Chinese firms purchase technologies from MNCs. However, this kind of technology transfer often leads to further technology purchase because the foreign suppliers seldom provide blueprints for the key components. It seems that domestic firms must be active in conducting R&D themselves in order to effectively make use of transferred technology and make technology progress. Otherwise, they often get stuck in technology chasing, rather than gaining a technology superiority.

About 67 percent of firms in low technology industries indicated that they have benefited from production technology brought in by FDI firms. This relates to the fact that the technology gap between domestic firms and FDI firms in low technology industries is narrower, and technology in these industries is inevitably easier to master. For instance, Shenbao Beverage Company increased their tea varieties inspired by foreign invested beverage firms in China.

Labour movement

The number of domestic firms and FDI firms which held training programmes, and the duration of those programmes, based on industry differences is presented in Table 8.13.

Table 8.13 Number of firms engaging in training by industries

	High technology industry		Low technology industry	
	Number of firms run training program	% in total	Number of firms run training program	% in total
Domestic firms	7	63	3	50
FDI firms	4	100	4	67

The survey shows that both domestic firms and FDI firms in high technology industries run more training programs than their counterparts in the low technology industries. This is presumably because the nature of the work in high tech industries requires more training. However, the differences between domestic firms and FDI firms in high technology industries is larger than that in the low technology industries. Since there is some correlation between training and labour skills, the gap in labour quality between domestic firms and FDI firms is expected to be higher in high tech industries than it is in low tech industries.

The operation of MNCs in the Chinese market helped to train a large number of entrepreneurs. However, the benefits of this would not diffuse to domestic firms if labour mobility is low. Responses to labour mobility questions indicate that there is higher labour mobility in FDI firms in low technology industries than in high technology industries. All the six mangers from FDI firms in this category interviewed stated that employers frequently leave their jobs for other opportunities. Yet managers in FDI firms in high technology industries indicated that their workforce is relatively stable. This is firstly because the wage gap between domestic firms and FDI firms in low tech industries is smaller than in high tech industries. Secondly, employees in low tech industries are often engaged in less specialised work than those in high tech industries and therefore find it easier to find a variety of work options. And thirdly, FDI firms in high tech industries often take measures to reduce the rate at which their skilled employees leave. For example, accommodation for talented employees is provided in Chaosun Machinery Company in order to keep these people with the firm. Many of those who left FDI firms to set up their own businesses are from firms in low tech industries because it requires less expertise and capital. The survey therefore indicates that spillovers based on labour mobility are higher in low technology industries than in high technology industries.

Forward and backward linkages

Forward linkages

The case studies revealed few differences between firms in high and low tech industries in terms of forward linkages. About 63 percent of domestic firms in high tech industries and 50 percent of domestic firms in low tech industries reported that they have purchased input from FDI firms. The tendency to purchase seems stronger in high tech industries where the quality gap between domestic firms and FDI firms is larger.

The purchase of products produced by FDI firms is often related to after sales services and technical assistance. This is mainly happening in high technology industries because local buyers need to learn how to use the products. For instance, the training for local buyers to use the equipment is a part of the package when the Chaosun Machinery Company sells its products to domestic firms.

In low technology industries such as the food and beverage industry, Chinese firms do not differentiate much between their suppliers because the quality differences between products is low. However, the situation in industries such as the garment industry is different as quality differences are greater. For example, the manager of Leifei Garment Company mentioned that the textile materials it purchased from FDI firms helped it to improve the quality of its garment products.

Backward linkages

FDI firms involved in high technology industries show limited tendencies to buy inputs from Chinese firms. Only one out of four FDI firms in high technology industry interviewed reported buying components from Chinese firms. The reasons for the limited purchase from Chinese firms by FDI firms include poor quality of products, complicated distribution systems, unreliable reputations, complicated management of domestic firms, and that FDI firms have long term overseas suppliers. FDI firms in high tech industries tend to obtain their inputs by importing from overseas suppliers or by purchasing from other FDI firms. However, many managers interviewed indicated that they keep an open mind on the possibility of using good domestic suppliers in the future. It can be expected that with the improvement of domestic technological and productive capacity, the ratio of local contents in the products of FDI firms will increase.

FDI firms in low technology industries showed a stronger tendency to purchase inputs from domestic suppliers. Four out of six FDI firms interviewed stated that they purchase over 50 percent of materials and components from Chinese suppliers. To supply intermediate inputs to FDI firms, domestic firms must enhance quality control and improve the standard of products. In some cases, FDI firms provide assistance in order to satisfy their own quality requirements. For example, the Red Peony Garment Company helped its domestic supplier in terms of designing garments.

8.4 Conclusions

This chapter investigates the channels for spillover effects from FDI to Chinese firms by using information from a recent survey of state-owned firms, collectively owned firms, and FDI firms in China. The study was largely confined to the task of comparing the channels of spillover effect between state-owned firms and collectively owned firms, and between firms in high and low technology industries.

Competitive pressure from FDI was found to be the major influence behind the spillover effect. This competitive pressure pushes firms to change their basic behaviour and move towards best practice, leading to further change of industrial structure in China. Both state- and collectively owned firms improved their efficiency when facing increased competition. However, collectively owned firms gained more because of their operational flexibility. Collectively owned firms also benefited from labour turnover from FDI firms. However, state firms have suffered from brain drain because large numbers of talented employees in SOEs move to FDI firms. Both state-owned and collectively owned firms have benefited from the demonstration effect of FDI firms, although this effect seems stronger for collective firms. While there are spillovers from forward linkages, spillover effects from backward linkage effects seems weak due to the low degree of interaction between Chinese suppliers and FDI firms.

The ability of FDI to transfer not only production know-how but also managerial skills distinguishes it from all other forms of investment such as portfolio capital. In the Chinese case, however, it appears that limited advanced technology diffuses from FDI firms to domestic firms. Chinese firms mainly benefited from the way of thinking and operating, management, and marketing skills that foreign firms bring in. Given that the difference between domestic firms and FDI firms often depends upon management and organisation rather than superior equipment and technology, considerable scope exists for raising productivity and output through the diffusion of management and marketing skills. Diffusing best-practice techniques, including management techniques, may be more critical than introducing more advanced technology into a few leading enterprises.

The case studies show that collectively owned enterprises generally benefited the most from the spillover effect of FDI. The continued government involvement in SOEs' decision making process, low incentive for managers and workers in delivering competitive performance, high indebtedness, heavy welfare burden, and rigid operation system all lead to the inability of state-owned firms to gain from the spillover effect. In contrast, collectively owned firms face few of the problems faced by SOEs. However, the survey also revealed that the benefits from the spillover effect could be increased if collective firms faced less discrimination in getting access to resources such as capital and basic infrastructure.

Findings from the case studies also reveal that spillovers are more significant in low technology industries. The lack of spillovers to domestic firms in high tech industries is attributed to a number of factors, including the big technology gap between domestic firms and FDI firms, the tacit nature of high technologies, very little labour mobility between domestic firms and foreign subsidiaries, limited linkage effects, and the unwillingness of MNCs to diffuse their knowledge to local competitors. Great effort as well as time and patience is required to master state-of-the-art technologies in high tech industries.

The study's evaluation of the channels of spillover effects in the Chinese context yields the following implications.

While there are studies that suggest state-owned firms have become more efficient without privatisation, evidence from the case studies suggests that SOEs in China have performed poorly in the wake of competition from FDI. The basic problems of state-owned firms cannot be overcome without fundamental privatisation. The failure to embark on a thorough privatisation program will retard economic progress.

Despite the decline of the central planning system and the growth of non-state-owned firms, the government still directly controls critical resources including capital, labour, and land. Non-state-owned firms including collectively owned firms would be more able to compete with FDI firms and gain from spillover effects if they could get access to resources based on commercial criteria.

The comparison between firms in high and low technology industries indicate that it is difficult to achieve a leap forward in improving the technological level. Technology leadership cannot be achieved through attracting FDI in high tech industries alone. Considerable effort and resources are required to master advanced technology. Domestic firms' ability to adopt advanced technology is limited unless they have strong capability to understand the technology and to attract skilled employees. The government may play some role in improving the basic education level and supporting firms in R&D and training.

Attracting FDI in high tech industries has been assigned high priority by the Chinese government. However, domestic firms cannot survive without advancement of science and technology in the face of competition from MNCs with advanced technology. With economic reform and development, Chinese firms will progressively build up technological capabilities and will be more capable of benefiting from FDI in high tech industries. China's open door policies have allowed it to gain advantages more rapidly in the low tech industries. With capital accumulation and technological progress, Chinese firms in high technology industries may be more capable of benefit from spillovers in the future.

The presence of foreign owned firms in the economy compels local firms to improve efficiency and technology. The exploitation of this potential, however, requires a conducive economic climate. In the absence of such a climate, FDI may be counterproductive. As the survey results substantiate, FDI has only provided benefits to certain firms in China. Domestic firms can benefit most if they have incentives and ability to compete with FDI firms, actively engage in learning, seek new ideas for improving, are able to attract talented employees from FDI firms, and engage in interaction with FDI firms such as selling and purchasing products from FDI firms.

Chapter 9

Conclusions and Policy Implications

Foreign direct investment (FDI) has played a major role in economic development in recent times. Growing evidence shows FDI can contribute to economic development by being a source of capital formation, providing technology, creating job opportunities, and assisting in industrial transformation. Recognition of these important roles has stimulated intensive effort by governments in many developing countries to attract FDI inflow. As a result, foreign direct investment has increased rapidly over the past two decades.

Among the roles of FDI, spillover effects have been recognised as an important benefit accruing to host countries. Indeed, it is the ability of FDI to transfer production know-how, as well as managerial skills, that distinguishes it from all other forms of investment such as portfolio capital. The importance of this role needs little defence, because the creation and diffusion of new technology is a major determinant of economic growth.

As a former centrally planned economy, China had long been closed to foreign trade and investment. Economic and political isolation resulted in stagnant economic development and lack of technological progress. By the end of the 1970s, it was evident that China had fallen behind in a world characterised by accelerated technological change. In order to catch up, the new leadership initiated a major economic reform program in 1979. A series of measures was pledged to attract foreign investment together with advanced technology. In recent years, China has gradually emerged as the largest recipient of FDI among the developing countries.

Two decades after the initiation of the reforms program, it is necessary to assess whether FDI has fulfilled the Chinese government's objectives in serving as a bridge of technology transfer between China and developed countries. More importantly, it is necessary to evaluate whether Chinese firms have benefited from the technological spillovers related to FDI inflow. While the return of foreign firms to the Chinese landscape was ideologically momentous, their contribution in diffusing technology and promoting growth has yet to be assessed.

To provide a comprehensive study of FDI and spillovers in China, it is important to take a wide-angle view. The assessment should be in a framework that combines theoretical analysis, empirical analysis, and detailed case studies. Yet such a study is barely visible in the existing literature on the relationship between FDI and growth in China. The present study attempts to fill this gap by investigating the impact of FDI inflow on domestic firms' productivity growth. In so doing, it seeks to improve understanding about the mechanisms through which FDI relates to the growth performance of domestic firms, and to contribute to the rational formulation of future FDI policies in China.

9.1 A Summary of the Study

9.1.1 Analytical Framework

Questions and hypothesis

The central questions (Chapter 1) this study seeks to answer are:

- First, given the existence of FDI in the Chinese economy, will technology necessarily spillover to domestic firms?

- Second, and more importantly, what are the principle determinants of spillovers from FDI to domestic firms?

The spillover hypothesis of FDI implies that firms in developing countries always benefit from FDI inflow. However, case studies and empirical research has not offered unambiguous support for this hypothesis. Among various studies which have examined spillovers from FDI in different countries, spillovers were found to exist only in some cases. One possible explanation is that spillovers may not be an effortless process. While it is clearly in the interest of domestic firms to increase technology spillovers, profit maximising behaviour by foreign firms influences them to prevent technology spillover to competing firms. Technological spillovers from FDI to domestic firms therefore depend on the interaction between the domestic and foreign firms. During this process, domestic firms play an important role in ensuring that the spillovers take place. These considerations lead this study to put forward a central hypothesis that the presence of foreign direct investment in domestic markets is only a necessary condition for domestic firms to gain from technology spillovers from FDI. The spillover effect itself is largely dependent on the domestic firms' behaviour.

When technology is not easily transferable across firms, two factors are considered important in determining the magnitude of spillover effects. The first is the domestic firms' incentive to learn from foreign firms, and the second is the domestic firms' ability to absorb the new technologies foreign firms brought in.

Theoretical analysis

The hypothesis is first examined in a theoretical setting (Chapter 4). A number of previous studies have analysed the relationship between FDI, technology transfer, and growth (Chapter 2). One common feature of these analyses is the focus on technology transfer from a MNC to its overseas subsidiary. Spillovers from the overseas subsidiary to domestic firms have been assumed to be automatic. Based on this assumption, a common conclusion is that the domestic firms' efficiency always increases with increased FDI inflow. Another common characteristic in these models is that they follow the hypothesis of Gerschenkron (1962), which states that the rate of technological progress in a 'backward' region is an increasing function of the technology gap between it and the 'advanced' region. Therefore, technology spillover is assumed to be proportional to the technology gap between foreign and domestic firms. These assumptions and conclusions are inconsistent with an increasing number of empirical observations.

Recognising that technology transfer from a parent company to a MNC subsidiary is not equivalent to technology spillover from the subsidiary to domestic firms, the model in this study focuses on exploring the ways in which FDI influences the TFP growth of domestic firms. The model considers an industry consisting of two firms, a domestic firm and a firm with foreign investment, engaging in Cournot-Nash competition. By taking into account the strategic interaction between these two firms, the model shows that FDI affects domestic firms' TFP growth through two factors.

On the one hand, FDI can increase domestic firms' TFP growth by bringing in advanced technology which may spillover to the domestic firms. On the other hand, domestic firms' TFP growth decreases when competition from foreign firms causes the domestic firms to cut production. Therefore, domestic firms' TFP growth can either increase or decrease with the increased FDI inflow.

Accordingly, two factors are proposed to determine the dominance of these effects. The first is the learning incentive and effort of the domestic firm. Strong incentive and effort can increase the gain from technology spillover. The second is the domestic firm's ability to learn, which, in turn, depends on the technology gap between the domestic and foreign firm. Contrary to most models, which incorporate the hypothesis of Gerschenkron (1962), the model treats the technology gap as an obstacle to technology spillover from foreign to domestic firms. Accordingly, a domestic firm is considered more likely to benefit from FDI when it does not face a great technological distance from the foreign firm. The demonstrated relationship shows that, to the extent that the entry of foreign firms is essential for the introduction and transmission of new ideas and knowledge, it is equally essential for domestic firms to be willing and capable of extracting gains from the spillover effect.

9.1.2 The Empirical Investigations

Comparison of TFP growth between state-owned, collectively owned and FDI firms

TFP growth is an important measure of the overall productivity and competitiveness of firms. Analysis of the relative performance of TFP growth between domestic and foreign firms is important for examining technological spillover effects (Chapter 5). A higher rate of TFP growth of the foreign firms is a necessary condition for the potential spillover to take place. Even in the absence of spillover effects, the high TFP growth of the foreign firms also increases the overall productivity of the domestic industry because the MNCs are a part of the national economy.

The most important feature of the Chinese economy is the coexistence of large numbers of state-owned enterprises (SOEs) and non-state owned enterprises. Since 1978, China has introduced a wide range of enterprise reforms, and state-owned enterprises have increasingly been given more control over production and management. In the 1990s, despite the reform efforts, SOEs still find themselves half-way between a command and market system. As a result they are plagued by problems related to public ownership, soft budget constraints, and heavy social responsibilities.

Following the move to a market oriented economy, the tight controls on the entry of non-state enterprises were greatly relaxed. This led to a sustained boom in non-state enterprises throughout China.[1] Non-state owned enterprises tend to have hard budget constraints, much clearer ownership structures, and they operate basically in accordance with market forces.

In order to compare the productive performance of Chinese firms in different industries, and with different ownership characteristics, this study investigated the TFP growth rate of 28 Chinese manufacturing industries in the state, collective[2] and FDI sector for the period 1993 to 1995. The investigation was carried out by obtaining output elasticities through estimating production functions in each industry and each ownership category. A growth accounting exercise was then conducted by using the elasticities estimated from the production functions.

Is the incentive and effort of learning by domestic firms important? Comparison of the spillover effect between state- and collectively-owned firms in China

The factors that influence a firm's technological behaviour are its property rights structure, market structure, and autonomy to react to market signals. The substantial differences between SOEs and collective firms in these areas have led to significant differences in their technological behaviour (Chapter 6).

Public ownership and the soft budget constraints of state-owned firms lead to low incentives to improve technology. As a result, SOEs are reluctant to commit themselves to long-term technology development. In recent years, the technology development of SOEs has been constrained by their poor financial situation.[3] SOEs

[1] From 1992, the output of non-state enterprises accounted for more than 50 percent of total industrial output and the proportion has been rising ever since.
[2] The collective sector is the major sector among non-state sectors, accounting for 74 per cent of the total output in the non-state sector in 1995.
[3] In 1995 about 40 per cent of SOEs made losses.

are also burdened by heavy social responsibilities and constrained by government interference. Before the reform period, SOEs had relatively advanced technology, but low utilisation of capital and asset neglect were common. In some industries, advanced equipment has been imported since the reform, but little has been absorbed and effectively applied in developing better products. All these factors have contributed to the continued deterioration of the SOEs' technological position.

While managers in SOEs are burdened with social responsibilities, collective firms can generally focus on economic objectives. Collective firms have much greater autonomy over production decisions and are able to produce at lower cost using the large surplus labour force that has been released by agricultural reform. Lower production costs have ensured the financial capability of technology improvement for non-state firms.

Most collective firms are small and have insufficient capital input. Under these circumstances, they generally engage in production that requires low levels of technology. Collective firms also make use of physical and human capital owned by SOEs. Given the substantially different efforts by collective and state-owned firms to obtain technology, it is not surprising that collective firms are rising from a poor foundation, while SOEs are falling behind despite their initial technical advantage.

Based on this situation, it is hypothesised that FDI in China may have a positive impact on collective firms' TFP growth and a negative impact on SOEs' TFP growth. The difference in spillover effect between state-owned and collective firms has been investigated by conducting tests using provincial industry-level data. Data include 28 manufacturing industries from 20 provinces for the period 1993 to 1995.

Recognition of the interdependence among various aspects of market behaviour is reflected in the use of a simultaneous equations model rather than a single equation model. Five endogenous variables are specified, namely, TFP growth, output share of FDI firms, export intensity, import intensity, and wage. Five simultaneous equations are set with the five endogenous variables as dependent variables respectively. The 2SLS method has been employed to estimate these equations.

How does the technology gap affect the spillover effect? Comparison of spillovers between high and low technology industries

High technology sectors have been considered by the Chinese government to be the most promising catalyst for future development. During the past two decades, promotion of capital and technology intensive industries has been one of the government's priorities. Great expectations have been placed on FDI in transmitting advanced technology to China. Special incentives have been granted to encourage FDI inflow in high tech industries. Despite this, the great bulk of FDI into China has been concentrated in small, labour intensive operations. The industrial distribution of FDI has been considered disappointing in fulfilling the government's expectations. In order to evaluate the FDI policies in China, it has to be asked whether policies encouraging FDI in high tech industries are able to deliver the government's objectives of improving the overall technology level of Chinese firms.

The answer to this question is linked to the relationship between the technology gap and the spillover effect (Chapter 7). Successful technology transfer means that technology is absorbed by the recipients. Following the analytical framework, this study considers that large technology gaps impede technology spillovers from FDI. Since China is a country with a large pool of unskilled labour, the 'absorptive capacity' of domestic firms in high technology industries is generally low. It is hypothesised that domestic firms in high tech industries may not be able to gain from the spillover effect, given that the technology gap between the domestic firms and the MNCs is large.

Tests have been carried out to determine the relationship between the spillover effects and the technology gap between domestic and foreign firms. Observations in 28 manufacturing industries have been divided into four groups according to the observed technology gap. Regressions have been run separately for each group. To concentrate on the industry differences, the tests only employ observations from the collective sector. For the same reason outlined in the test for the ownership differences of spillovers, the two stage least square technique has been used to capture the causality effect between endogenous variables. Five simultaneous equations have been included in the system.

Channels of spillover effect

Case studies are necessary in conveying qualitative information with regard to channels for spillover effects. This information is difficult to quantify without losing some part of their true meaning, yet it is essential for understanding the mechanism through which FDI affects the technological behaviour of domestic firms.

Information for the case study (Chapter 8) was obtained from a survey of 27 selected firms in Shenzhen, which is the oldest and most established Special Economic Zone (SEZ) in China. The sample covers state-owned firms, collectively owned firms, and firms with foreign investment. It also covers industries which are conventionally identified as low technology industries and high technology industries. Comparing the channels of spillover effect between state-owned and collectively owned firms, and between firms in high and low technology industries, forms the focus of the case studies. The channels examined include competition from FDI firms, labour turnover, demonstration effect, and backward and forward linkages

9.2 Main Findings and Policy Implications

The growth performance of firms in different ownership categories

Large difference in productive performance were found between firms in different ownership categories (Chapter 4). Sectors with FDI experienced the highest TFP growth, followed by the collective sector. Most industries in the state sector experienced negative or stagnant TFP growth.

The difference in TFP growth between the different ownership categories suggests that firms operating in a market environment are more likely to have high TFP growth. The significantly poorer productivity growth performance of SOEs indicates the importance of continued reform for state-owned firms. The government should also further lessen institutional constraints which restrict the entry of non-state-owned firms.

The industry difference of TFP growth suggests that sectors with a lower capital labour ratio have a better productive performance. The TFP growth gap between domestic and FDI firms is also higher in capital intensive industries. This finding is consistent with China being a developing country with comparative advantages in labour intensive industries. The implication for this finding is that the government's effort to encourage the development of capital intensive industries may not be a rational measure during the early stages of development.

The study also suggests that FDI contributes positively to the national economy in terms of increasing productivity growth. Being a part of the Chinese economy, the higher TFP growth of FDI pushes up the overall productive performance of the economy as a whole. It also provides the potential for spillover to take place.

How spillovers differ between state- and collectively owned firms

The most interesting conclusion from the econometric study distinguishing the impact of FDI on TFP growth for state-owned and collectively owned firms is that the domestic firms' behaviour is critical in determining the spillover effect (Chapter 5). TFP growth of collective firms is found to be positively related to FDI, while that of the state-owned firms is negatively related. By comparing the ownership structure and behaviour of state and collective firms, it is clear that incentive and efforts to improve technology are the causes for this difference. When the learning effort is low and when the domestic firm cannot effectively compete with the FDI firm, the domestic firm's TFP growth will fall with the expansion of the FDI firms' production.

This leads to the suggestion that policies to create a more competitive market environment will foster spillover effects from FDI. Reform of the state-owned firms has been at the top of the government policy agenda since the early 1990s. However, due to ideological and political reasons, the attempt to reform SOEs did not involve major changes to their state-owned nature. Despite the painful process, the only way for the struggling state firms to be able to compete effectively is to change their basic behaviour. Fundamental problems that need to be addressed include those related to property rights, soft budget constraints, and heavy social responsibilities.

Despite the decline of the central planning system and the growth of non-state-owned firms, the government still directly controls critical resources including capital, labour, and land. Compared with the long term subsidy to state-owned firms, non-state-owned firms are disadvantaged in getting access to resources. Non-state-owned firms would be more able to compete with FDI firms, and gain from spillover effects, if they could get better access to resources based on commercial criteria.

Regardless of the successful performance of the collective firms over the past twenty years, to some extent, the form of collective firms is a compromise to the current political and economic reality in China. As economic reform deepens, and as China moves to a more market oriented system, collective firms will probably become a less desirable form of organisation. As a result, reducing the high transaction cost induced by government interference and providing fair conditions for private firms should be emphasised.

How spillovers differ between industries

Results from the regression comparing the spillover effect between industries show that spillovers are positive and significant in industries which are mainly labour intensive (Chapter 7). These industries have a low to moderate technology gap between Chinese and foreign firms. However, in the industries with high technology gaps, the spillover effect appears to be insignificant. Overall, the results present a negative relationship between spillovers and the technology gap between domestic and foreign firms.

These findings suggest that technology cannot be absorbed by local firms when the technological gap between them and the foreign partner is too large. Measures aimed at promoting FDI in high technology industries are insufficient to generate spillovers. Simple technologies in labour intensive sectors allow the exploitation of knowledge that is more readily available at the early stage of development. Therefore, special treatment for FDI in high technology industries, and discrimination against the labour intensive sector, may not only be costly and ineffective in promoting technology development in China, but could also delay the process of 'labour-intensive' industrialisation.

Domestic firms' technological capability is crucial in enabling them to adapt technology to local circumstances and diffuse it throughout the economy. It is impossible for them to make a rapid leap forward to become a country with advantages in high tech industries. Intensive effort needs to be made to improve

China's absorptive capability. The accumulation of human capital, physical capital, and the mastery of technological skills by local firms, are all necessary for spillovers to take place. Therefore, investment in basic infrastructure, education and training, and encouraging domestic firms to engage in R&D are all important.

Channels of spillover effect

The case studies have shed more light on the mechanisms through which the spillover effect operates (Chapter 8). Among the channels investigated, competition from FDI was found to be the major channel for spillover effects. Competitive pressure pushes domestic firms to change their basic behaviour and move towards best practice. Labour turnover also appears to be important. The role played by backward and forward linkages seems to be limited because limited interactions exist between domestic and foreign suppliers.

In the Chinese case, it appears that few advanced technologies diffuse from FDI firms to domestic firms. Chinese firms mainly benefited from the management and marketing skills the foreign firms brought in. Marketing and management skills have not been sufficiently emphasised by the Chinese authorities. However, given that the different performance between domestic and FDI firms often depends upon management and organisation, rather than superior equipment and technology, the diffusion of management techniques may be more critical than introducing advanced technology into a few leading enterprises. Foreign firms have also demonstrated a new way of operation and a new way of thinking. This is important in exposing Chinese firms, which have been under central planning for decades, to market oriented management and organising systems.

The case studies further confirmed that state-owned firms and collectively owned enterprises have different experiences with the entry of foreign invested firms. The continued government involvement in SOEs' decision making process, combined with low incentives for managers and workers in delivering competitive performance, high indebtedness, a heavy welfare burden, and a rigid operating system, have led to the inability of state-owned firms to gain from spillover effects. Facing the increased competition from foreign invested firms, the market share of many state firms is decreasing. Little attention has been paid to learning the technologies and skills demonstrated by foreign firms. State firms have also suffered from brain drains because large numbers of talented employees have moved to FDI firms. There is little linkage between state-owned and foreign invested firms, because few foreign invested firms act as sources of demand for products produced by state-owned firms.

While there are studies that suggest state-owned firms have become more efficient without privatisation, the evidence from these case studies suggests that the SOEs have performed poorly in the wake of competition from FDI. The basic problems of state-owned firms cannot be overcome without fundamental reform of their state ownership, and failure to embark on a thorough privatisation program will retard economic progress.

Facing increased competition from FDI, collectively-owned firms in general gained more because of their operational flexibility. Collectively-owned firms also benefited from labour turn over from FDI firms, demonstration effects, and forward linkage effects. However, the spillover effect from backward linkage effects seems weak due to the low degree of interaction between Chinese and FDI firms. The survey also revealed that benefits from the spillover effect could be increased if collective firms faced less discrimination in getting access to resources such as capital and basic infrastructure.

The case studies also revealed that spillovers are more significant in low technology industries. The lack of spillovers to domestic firms in high tech industries is attributed to a number of factors, including the tacit nature of high technologies, the limited labour mobility between domestic firms and foreign subsidiaries, together with limited linkage effects, and the unwillingness of MNCs to diffuse knowledge to their local competitors.

Comparison between firms in high and low technology industries further confirms that technology development is an evolutionary process. Diffusion involves more than the acquisition of machinery or product design. The domestic firms' ability to adopt advanced technology is limited unless they have a strong capability to attract skilled employees and understand the technologies. Chinese firms need to build up technological capabilities in high tech industries. Without advanced capability, domestic firms will have difficulty surviving in the face of competition from MNCs with advanced technology. In this sense, it appears more sensible to let the market decide the industrial distribution of FDI inflow to China.

Spillover effects are also related to economic policies and reforms in a broad framework. The case studies suggest that spillovers from FDI could be enhanced through labour market reform which increases labour movement between domestic and foreign firms. The potential for spillovers could also be increased through increased linkages between domestic and foreign firms. This not only increases interaction in terms of supplying components between domestic and foreign firms, but also increases opportunities for suppliers and recipients to work together to modify the technology to suit new problems and conditions. Continued economic reform will enable Chinese firms to operate according to market rules and to compete in a level playing field with MNCs, and could be expected to increase the benefit of spillovers from FDI.

9.3 Directions for Future Research

This study investigates foreign direct investment inflow and spillover effects in the Chinese manufacturing industry. It attempts to examine the issue by applying the tools of theoretical and empirical analysis, as well as case studies. It not only seeks to test the existence of spillover effects, but also attempts to explore the mechanism and channels through which the spillover effect takes place. Emphasis is placed on the role of domestic firms in determining the existence and magnitude of the spillover effects. Firms in three ownership categories - state owned, collectively owned, and foreign invested firms - and in different industries, have been studied to allow a broad comparison to be made. However, given the complexities of the nature of spillover effects, many aspects of this issue remain unexplored and could be productive areas for future research.

Theoretically speaking, the model developed is capable of accommodating some aspects of the relationship between FDI and domestic firm's TFP growth. However, the analysis has been confined in a static partial equilibrium framework. As both innovation and diffusion take time, a dynamic model would be better able to reflect the nature of the spillover effect. One direction for further research would therefore be the introduction of a model which captures the dynamic characteristic of spillover effect. Analysing the issue in a general equilibrium framework, with the decision of the subsidiary's technology import being internalised, should also be addressed.

In the empirical aspect, the panel data set employed in this study has provided a large degree of freedom. However, as in most econometric tests, the data set has some limitation. The model covers only three years. The absence of a longer period of time series data on FDI precludes the design of a model which conveys more accurate information about spillover effects. This study has also examined spillovers by using industry level data. Analysis employing information at the firm level may also help to provide a better understanding of the issue.

Although information collected from case studies is sufficient for providing information on the channels of spillover effect, conclusions from a sample with 27 firms may be biased. Moreover, the sample size of the interviewed firms is not statistically large enough for statistical tests.

With the growing appeal of the new growth theories, technology has returned to the centre stage of economic development. Along with trade, foreign direct investment is now regarded as one of the key factors in transferring technology and driving economic growth. Given the complexities of the Chinese economy, the current study provides only a small step toward the clearly defined relationship of FDI and spillovers in China. Nevertheless, as Vernon (1966) stated more than three decades ago:

> 'Unless the search for better tools goes on, the usefulness of economic theory for the solution of problems in international trade and capital movement will probably decline'.

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